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ABSTRACT

Designed to be a workable guide for instructors serving the occupational needs of various categories of disadvantaged and handicapped students, this welding curriculum contains fourteen units of self-paced and self-contained instructional materials. The instructional units cover the following topics: job opportunities in welding, safety rules in gas welding, lighting and adjusting a welding torch, running a bead with or without filler rod, brazing a butt joint, flame cutting metal, safety rules in arc welding, striking an arc, running short beads with an electrode, welding in a flat position with an electrode, and welding a bevelled butt joint and a lap joint with an electrode. Each unit consists of five color-coded sections that present (1) student objectives and self-assessment statements to help students determine their ability to perform the unit objectives; (2) a brief motivational statement describing the theme of the unit; (3) description of the tools, materials, and equipment necessary for a given psychomotor skills lesson; (4) step-by-step explanations and illustrations of a given skill; and (5) true-false, identification, and steps-of-procedure evaluation sheets to be used by instructors to evaluate student performance. (MN)

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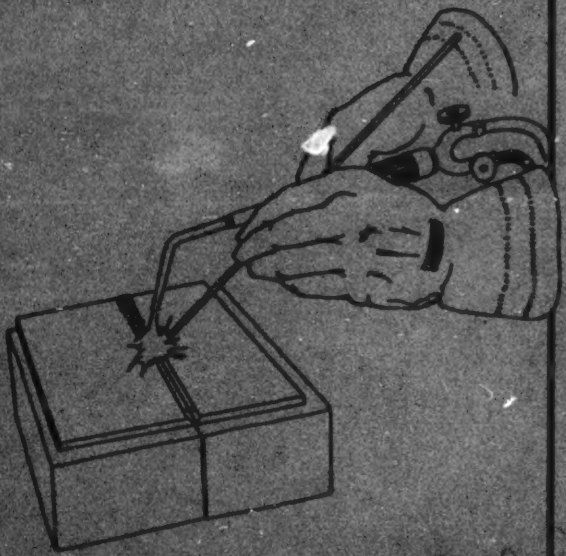
Vocational Preparation Curriculum



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Welding

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Developed by: Hogan Usoro

PRACTICAL ARTS
AND
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EDUCATION

Vocational Preparation Curriculum
WELDING

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Vocational Preparation Curriculum
WELDING

Preface

This Vocational Preparation Curriculum guide is a Special Needs project sponsored by the Missouri Department of Elementary and Secondary Education. The purpose of this curriculum guide is threefold:

1. to provide minimum skills for disadvantaged and handicapped students entering the mainstream
2. to supplement vocational skills of those students already in a regular training program (mainstream)
3. to provide vocational instructional materials for the modified classroom

This guide is intended to be a workable guide for instructors serving the occupational needs of various categories of Disadvantaged and Handicapped students.

Fourteen units of self-paced and self-contained instructional materials are contained within this welding curriculum. The units are generously illustrated to more easily aid the student in class activities.

Each unit within the welding curriculum is color coded to represent a separate section within the unit, the color coding is explained as follows:

White: Objective and Student Assessment - This sheet presents the unit objectives. The student must meet these objectives to successfully complete the unit.
The self-assessment statements help the students to determine their ability to perform the unit objectives.

Goldenrod: Introduction - Contains a brief motivational statement describing the theme of the unit.

Salmon: Tools, Materials, and Equipment - This section introduces new tools, materials, and equipment necessary for a given psychomotor skills lesson.

Canary: Steps of Procedure - Presents a step by step explanation and illustration of a given skill.

Pink: Student Evaluation - These sheets are used by the instructor to evaluate student performance. Three different forms of evaluation are presented; true-false, identification, and Steps of Procedure evaluation.

It should be noted that the material within this curriculum was developed to provide a source and guideline for the instructor. The responsibility of the instructor will be to adapt material as is necessary to suit a given teaching/learning situation. It is hoped that this material will provide that basis.

Vocational Preparation Curriculum
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Acknowledgments

The Vocational Preparation Curriculum guide is the outcome of the expenditure in time, effort and talents of the following individuals.

Committee Members:
Ed Flanigan, Instructor, Waynesville Area Vocational-Technical School
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Mr. Larry Lutz: Director, Camdenton Area Vocational-Technical School

Instructional Materials Laboratory, University of Missouri-Columbia
A special appreciation is accorded Dan Stapleton, graphic designer for the illustration, design, layout and production of this guide
Tammy Begley: Composition typist, for her work in typesetting and editing
Phyllis Miller: Editor, for editing the curriculum material
Dr. Harley Schlichting: Director of Instructional Materials Laboratory, for his special assistance in the preparation and completion of this Vocational Preparation Curriculum

Appreciation is also expressed to Dr. F.M. Miller of the Practical Arts and Vocational-Technical Education department and Dr. C.T. Cameron, Special Education department, University of Missouri-Columbia, for their contributions toward the development of the format in this curriculum.

A special thanks goes to all the other individuals who made contributions toward the completion of this project.

Notes to the Instructor

Step 1 Read through the information in this unit before presenting it to the student.

Step 2 Make sure all tools and materials to be used in this unit are available.

Step 3 Prepare any handouts, if applicable, to aid student learning activities.

Step 4 Provide the student with self-assessment (objective) sheet.

Step 5 Discuss tasks on self-assessment sheet and give directions for completing the Show What You Can Do section.

Step 6 Have student complete self-assessment sheet.

Step 7 If the student elects to take the Practical Exercise and completes it to the satisfaction of the instructor, have the student proceed to the next package. If the student fails to complete the Practical Exercise to your satisfaction or does not wish to take the exercise, proceed to Step 8.

Step 8 Provide and discuss the Introduction sheet with the student. At this time you can also discuss the Tools, Materials and Equipment list.

Step 9 Provide the student with Steps of Procedure.

Step 10 Present the Steps of Procedure. Depending on the capabilities of the student, select one or more of the following means of presentation:

a. have student study information independently,

or

b. go through the Steps of Procedure with the student individually or as a group.

Step 11 Instructor can demonstrate the procedures to the student or the group.

Step 12 Allow the student time to practice the procedure.

Step 13 When the student feels ready, use the Practical Exercise Checklist to evaluate the student's performance capabilities.

Additional Suggestions for the Instructor

Try team approach when possible.
Beginning students can work together after instructor's demonstration.
One student experienced with the procedures can work with a beginner.

For non-readers, audiotapes or videotapes of the lesson could be prepared.

Review tools and materials with the students whenever necessary. Tools and Materials Identification Exercises are provided in some units for instructors' use.

Tools and Materials Identification Exercises can be used in the following suggested way:

As a pencil and paper exercise

Actual Tool/Material Identification: Instructor holds up or points to an actual tool or material for the student to identify, or the instructor names a particular tool or material and asks the student to locate it.

Name-Object Association: Instructor prepares cards with names of tools and materials. The student matches the name card with correct object.

Additional modifications of above suggestions can be effected by the instructor to take care of other disadvantaged/handicapped conditions.

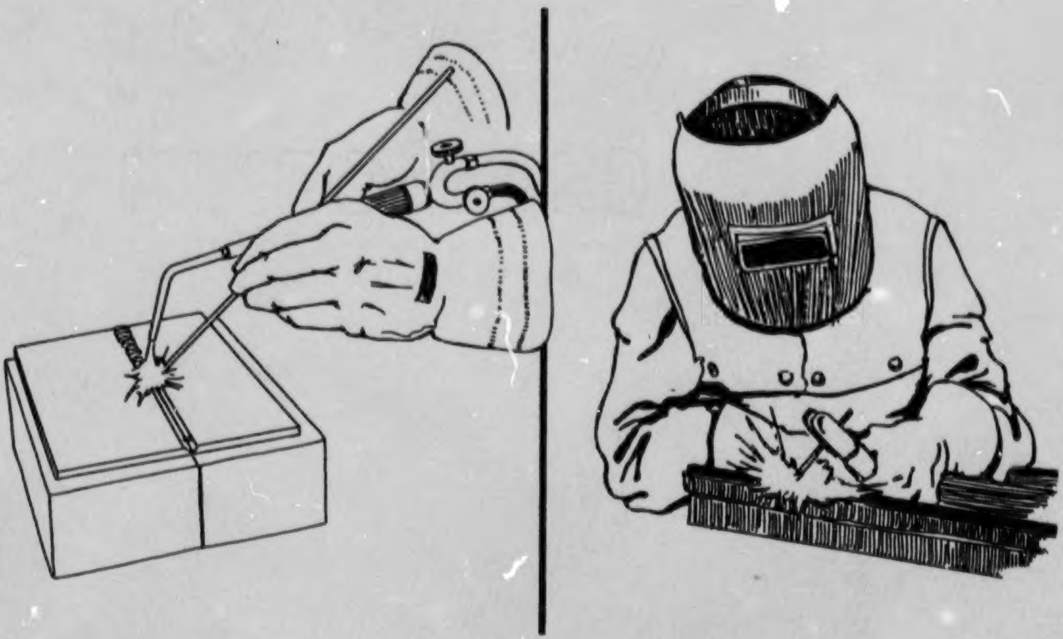
Plan visits to local welding shops.

Vocational Preparation Curriculum
WELDING

Class Progress Chart

											Student's Name WHAT THE STUDENT CAN DO
											Light and Adjust a Welding Torch
											Run a Bead without Filler Rod
											Run a Bead with Filler Rod
											Braze a Butt Joint
											Braze a Lap Joint
											Flame Cut Metal
											Strike an Arc
											Run Short Beads with an Electrode
											Weld in a Flat Position with an Electrode
											Weld a Beveled Butt Joint with an Electrode
											Weld a Lap Joint with an Electrode
											Instructor's Signature Date

Vocational Preparation Curriculum
WELDING



Unit 1

Job Opportunities in Welding

Developed by: Hogan Usoro

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Unit 1
Job Opportunities in Welding

Job Opportunities in Welding.

After you study this lesson, you should be able to:

1. Name and locate a welding shop in your community.
2. Identify some job opportunities in welding.
3. Name a welding occupation you would like to follow and give some reasons why.

Show What You Can Do.

Check the statement that fits you best.

1. ☐ **I can do all the tasks above and want my instructor to give me the Practical Exercise.**

SEE YOUR INSTRUCTOR

2. ☐ **I want to study the information in this unit before I do the Practical Exercise.**

TURN THE PAGE AND BEGIN

Unit 1
Job Opportunities in Welding

Introduction

Can you imagine how this world would be if we had no way of joining metals? It would be impossible to build an unbroken rail line from Detroit to New Orleans or to have a pipeline running across Alaska. It would also be impossible to construct something as large as an oil supertanker or as small as a bicycle frame if not for welding.

Welding is one of the most exciting industrial activities that you can do. But to succeed in a welding career you must develop your skill and gain experience. A welding class can help you very much.

This first unit will show you job opportunities, locations and job titles available to you as a welder.

TURN TO NEXT PAGE

Unit 1
Job Opportunities in Welding

A. Welding Shops and Types of Welding Jobs in Your Community.

Welding plays an important part in many people's lives because it is used in making many of the items we use daily. Welding jobs are found throughout the United States and around the world. These jobs range from very simple to very complex assignments. A basic knowledge of welding is needed regardless of the type of welding you want to do.

Let us discuss the welding shops and activities in your community.

1. Name a welding shop in your community.

   ____

2. What kind of welding jobs does the welding shop do?

   ____

3. Are there other welding shops in your community?

   ____

If you said yes, talk about these with your instructor or with the class.

TURN TO NEXT PAGE

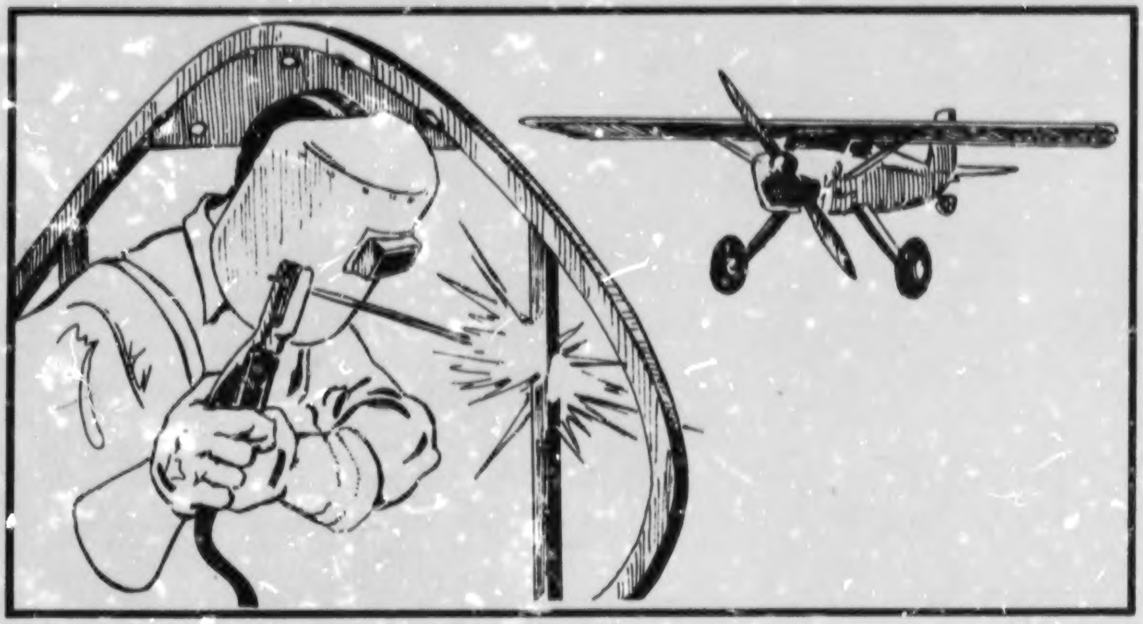
B. Job Opportunities in Welding.

Did you know there are over one-half million people who earn their living as welders? In some jobs and locations welders can earn more than $30.00 per hour. Welders are some of the highest paid workers in the United States.

Job Opportunities in welding are almost unlimited. After training as a welder you can work in a variety of locations and a variety of welding occupations.

Some of the larger welding occupation areas are:

AIRPLANE CONSTRUCTION:
An arc welder welding the frame of a small airplane.



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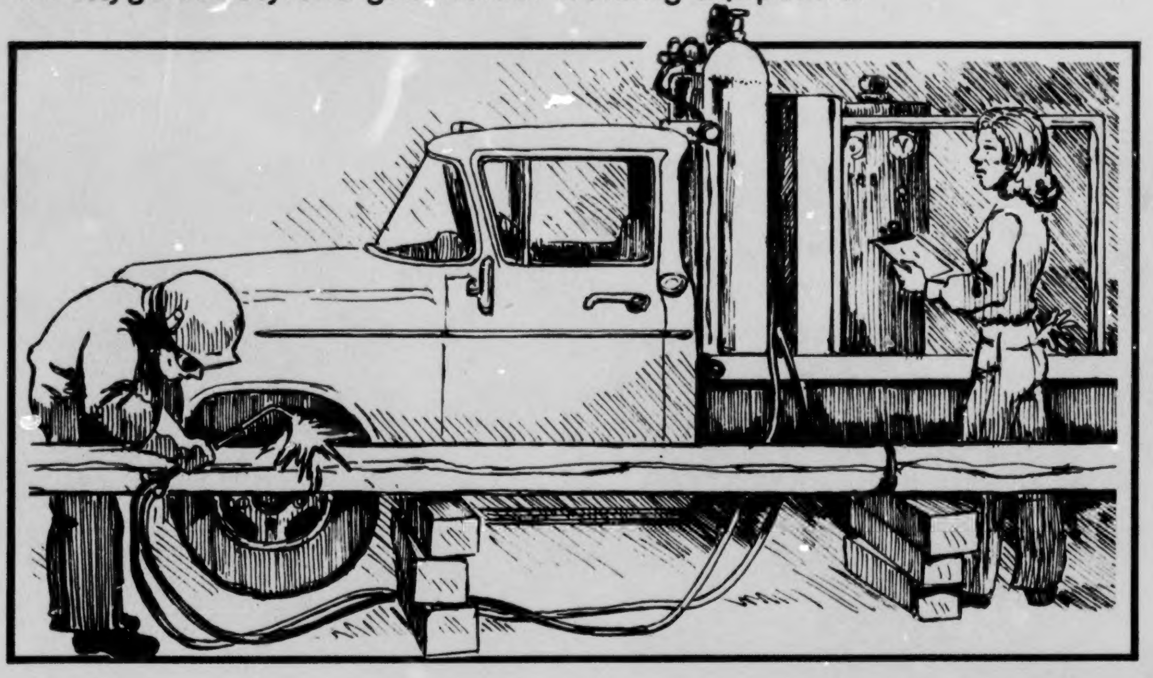
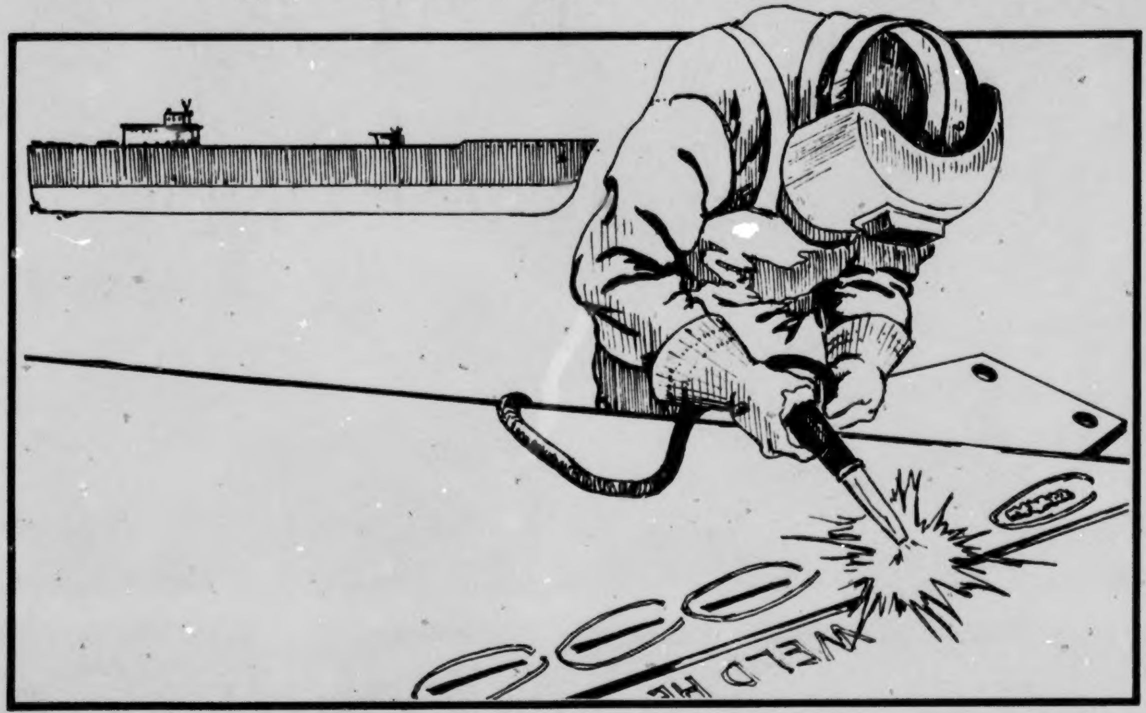
PIPELINE INSTALLATION:
An oxygen/acetylene gas welder welding a pipeline.

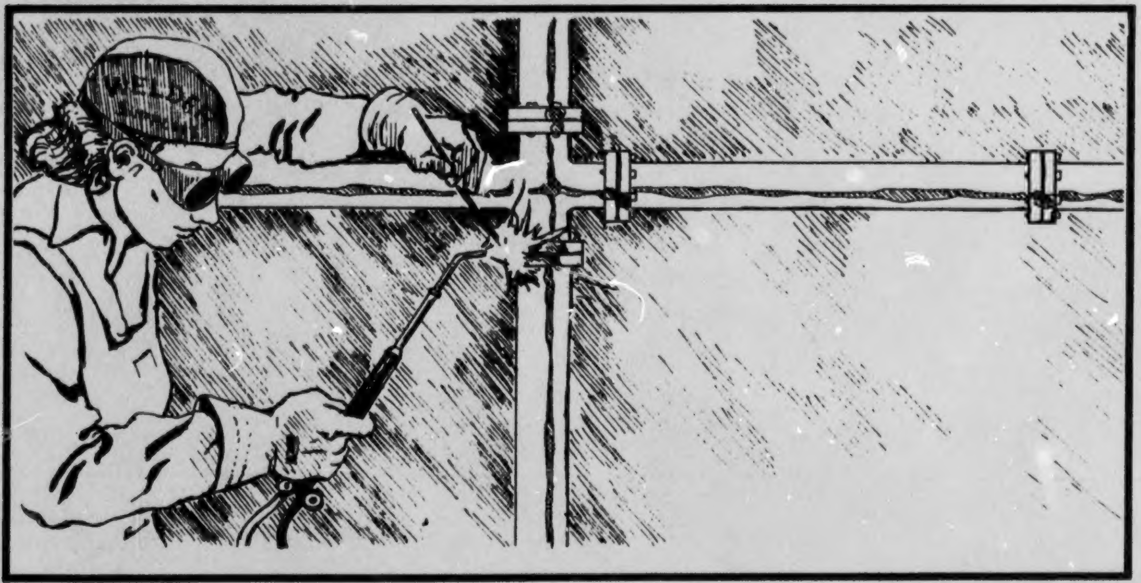


SHIPBUILDING:
A welder using special equipment to weld a giant oil tanker.



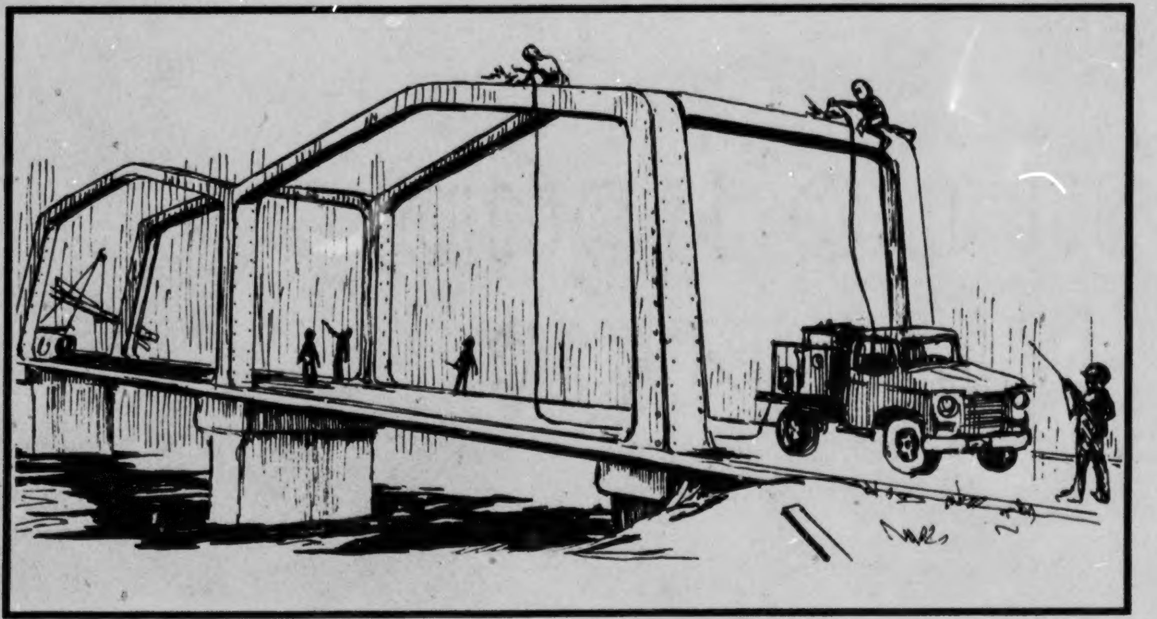
BUILDING CONSTRUCTION:

A welder soldering water pipe connections in a large office building.

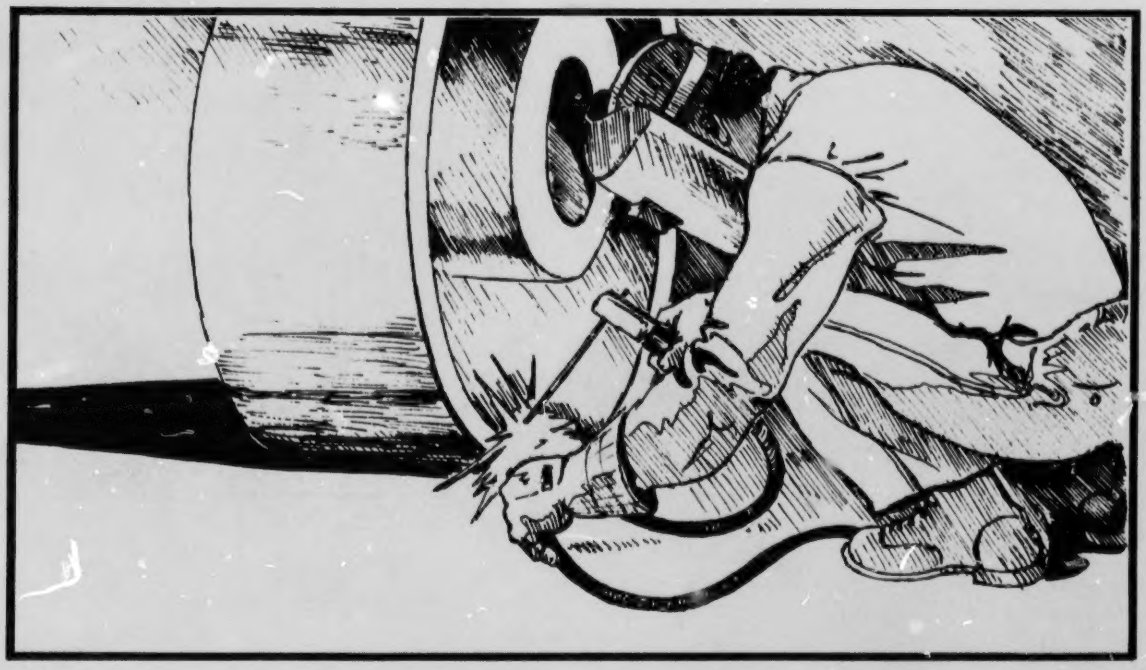


BRIDGE CONSTRUCTION:

Arc welders building a steel bridge.

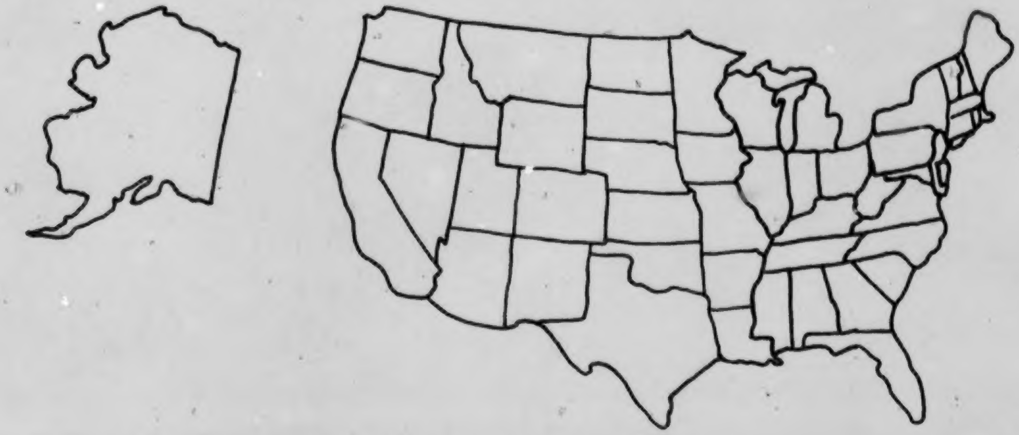


STEEL CONSTRUCTION:
An arc welder welding a part of steel machinery in an industrial plant.



Look at the map and pick out some states you think would require a large number of welders.
What types of welding opportunities are in the states you picked?

Locate an area where you would like to have a welding job. Why?
What kind of welding job would you most likely have there?



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Unit 1
Job Opportunities in Welding

Job Titles in Welding

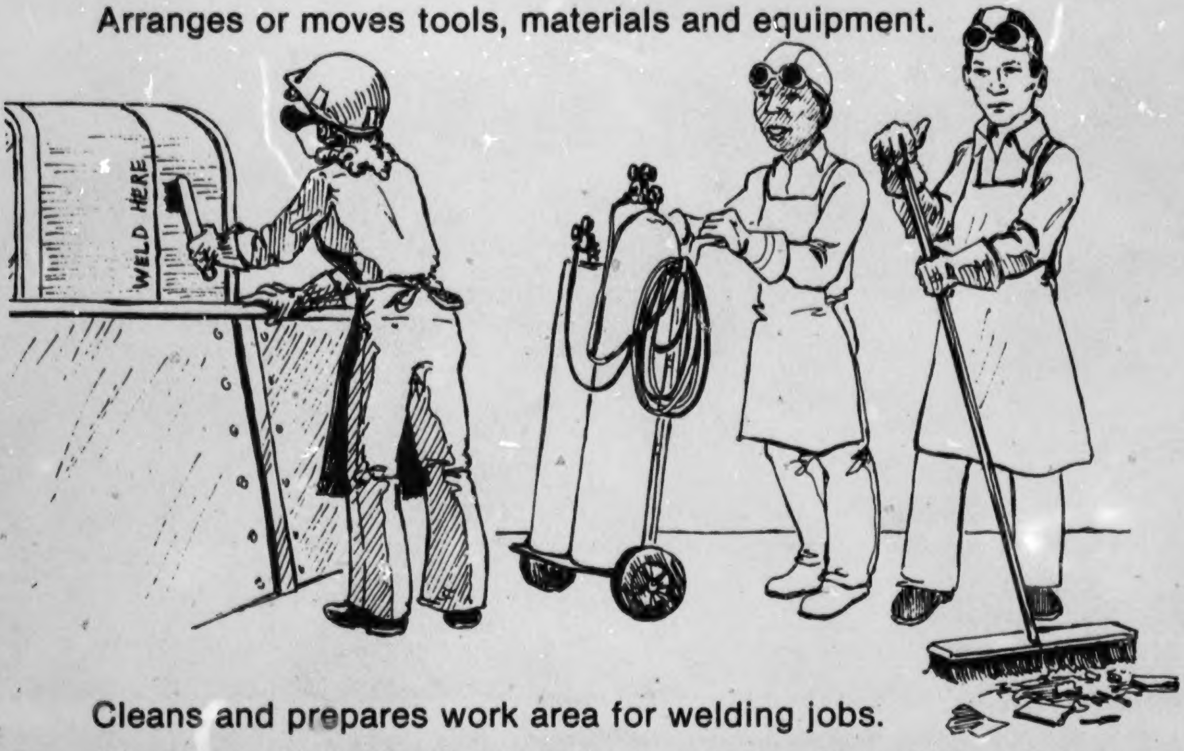
A job title describes the kind of work you do. In welding there are many different job titles. The title you earn depends on your training and degree of skill. In some cases it takes a long time to develop a high degree of welding skill to earn a certain job title.

Some of the job titles in welding for which you may be qualified after completing your training are shown here. Look at these and think about the type of work you would like to do.

1. **WELDING HELPER:** Assists the welder by doing a variety of tasks:

   Cleans metal pieces for proper welds.

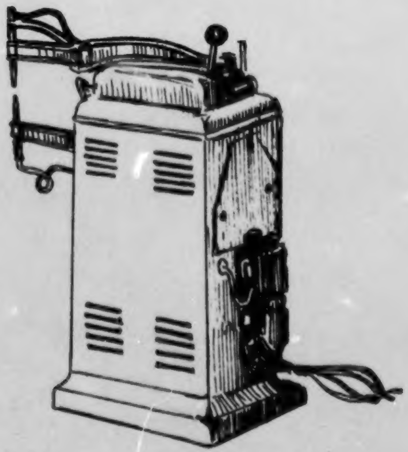
   Arranges or moves tools, materials and equipment.



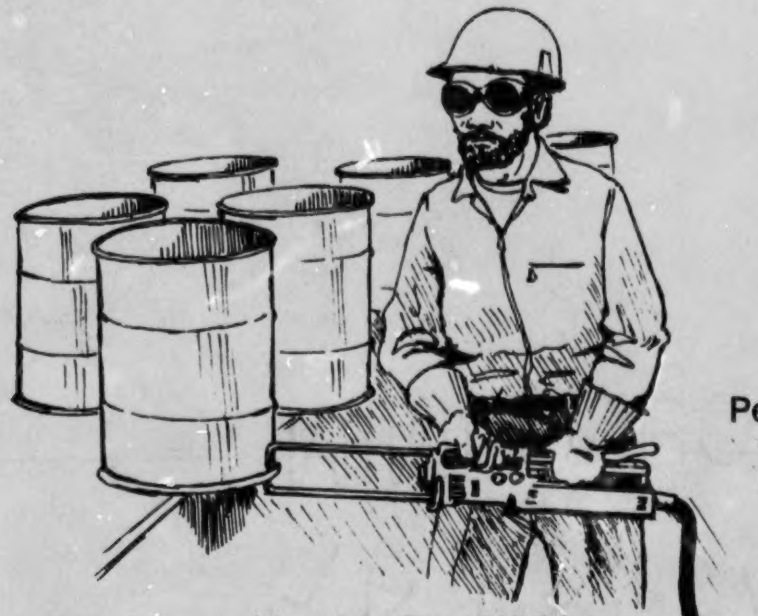
   Cleans and prepares work area for welding jobs.

   Clamps or places work pieces correctly on the welding table for welding.

2. **SPOT WELDER:** Uses spot welding equipment to spot weld a variety of sheet metal products.

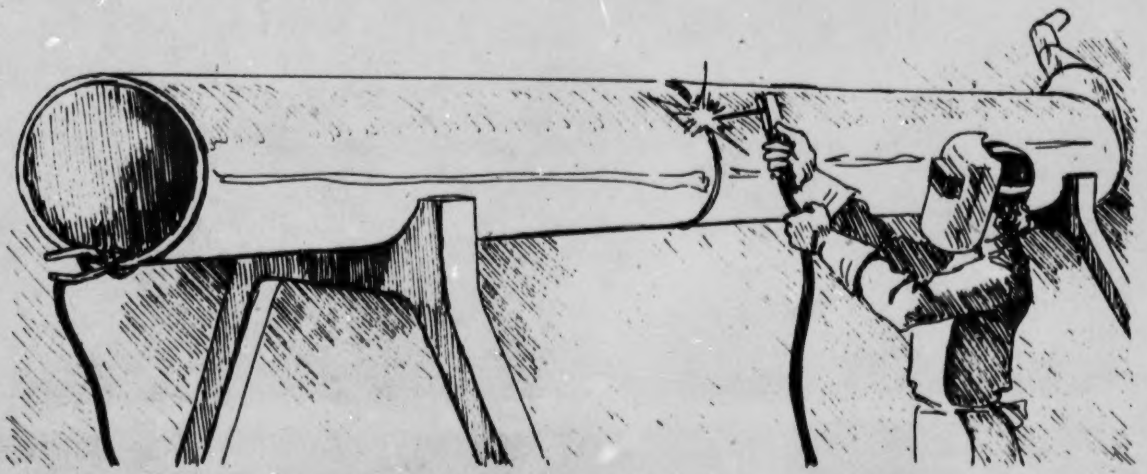


Permanent Spot Welder

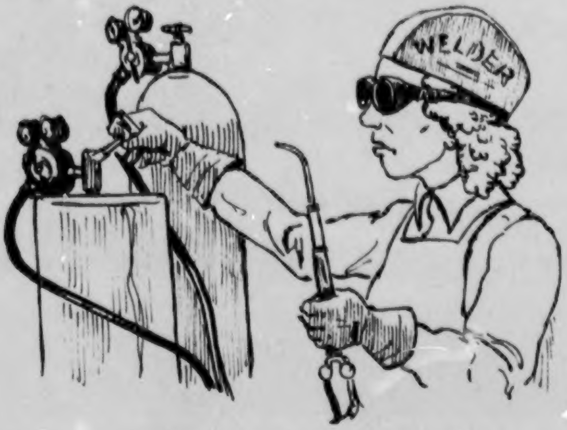


Movable Spot Welder

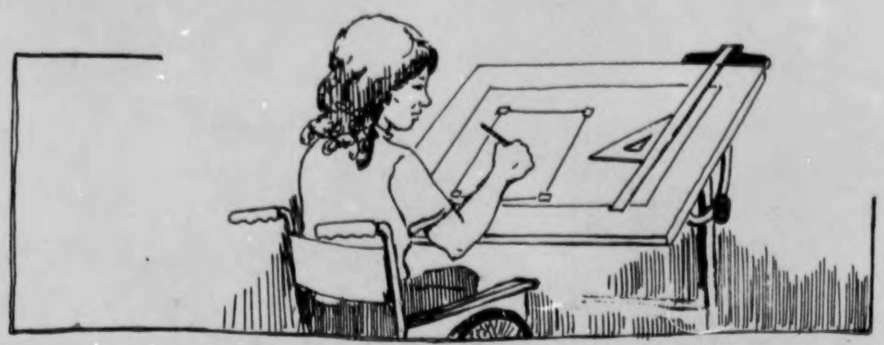
3. **PIPE WELDER:** Welds seams and ends of pipes for continuous run of steel pipelines.



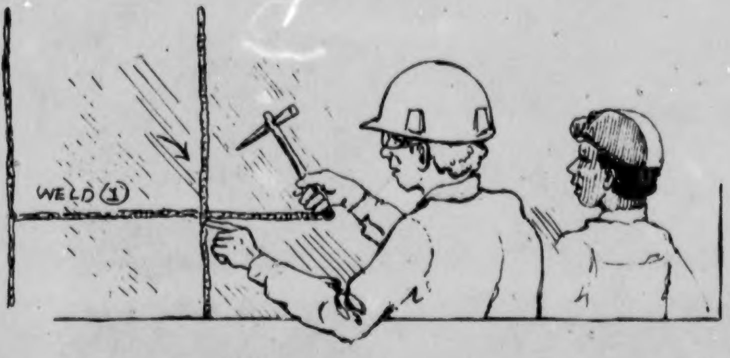
4. **WELDING OPERATOR:** Checks, maintains, repairs and operates welding equipment so that it remains in good operating condition.



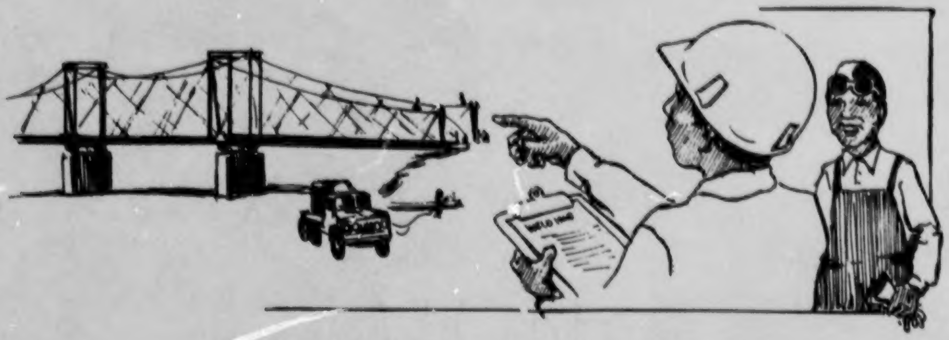
5. **WELDING TECHNICIAN:** Makes designs, layouts and blueprints for welding projects and assignments.



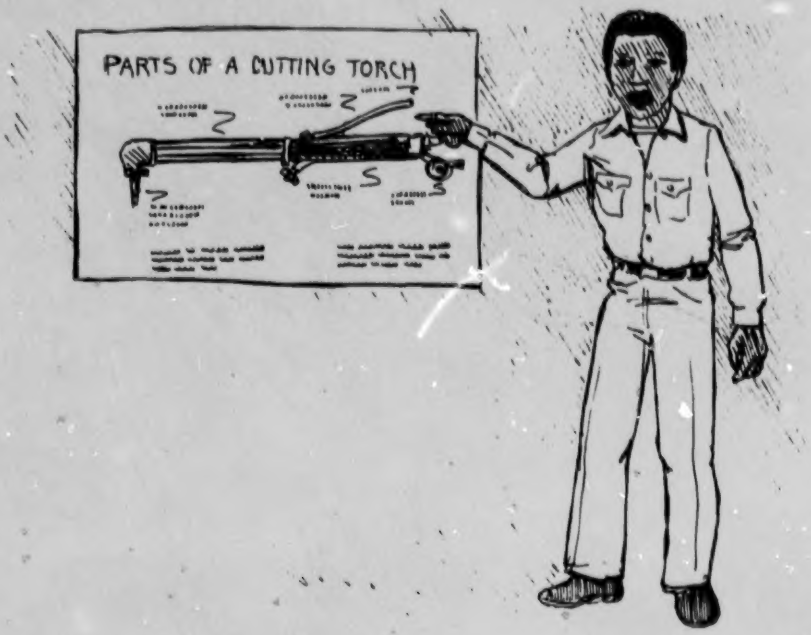
6. **WELDING INSPECTOR:** Checks and inspects finished welding jobs to see that welds are safely and correctly done.



7. **WELDING SUPERVISOR:** Supervises welding job assignments to see that they are finished on time and are correctly and safely done.



8. **WELDING INSTRUCTOR:** Teaches students uses of tools and equipment, safety rules, and welding procedures.


PARTS OF A CUTTING TORCH

SEE YOUR INSTRUCTOR

Unit 1
Job Opportunities in Welding

Practical Exercise Performance Checklist

Student's Name: ______________________________

True - False Questions:
Circle "T" if the statement is "True " and an "F" if it is "False."

T F 1. A welding supervisor makes sure that a welding task is done correctly, safely, and on time.

T F 2. A welding supervisor always does the welding job alone.

T F 3. If you are a welding operator, your job is to check, maintain and repair welding equipment.

T F 4. One of the responsibilities of a welding inspector is to test finished welding jobs.

T F 5. One of the things a welding helper does is to arrange welding tools, materials and equipment for easy use.

T F 6. A welding technician is one who designs and lays out welding projects.

T F 7. If you are a spot welder, you cannot assemble sheet metal products.

T F 8. Railway construction is an occupational area in which welding is not needed.

T F 9. Airplane construction certainly involves a lot of welding work.

T F 10. In order for you to teach welding, you must know how to weld properly.

T F 11. Without welding, people would find it almost impossible to do most construction jobs.

T F 12. Welding is important in our lives because most of the items we use daily are produced by welding.

T F 13. There are very few job opportunities in the welding occupation.

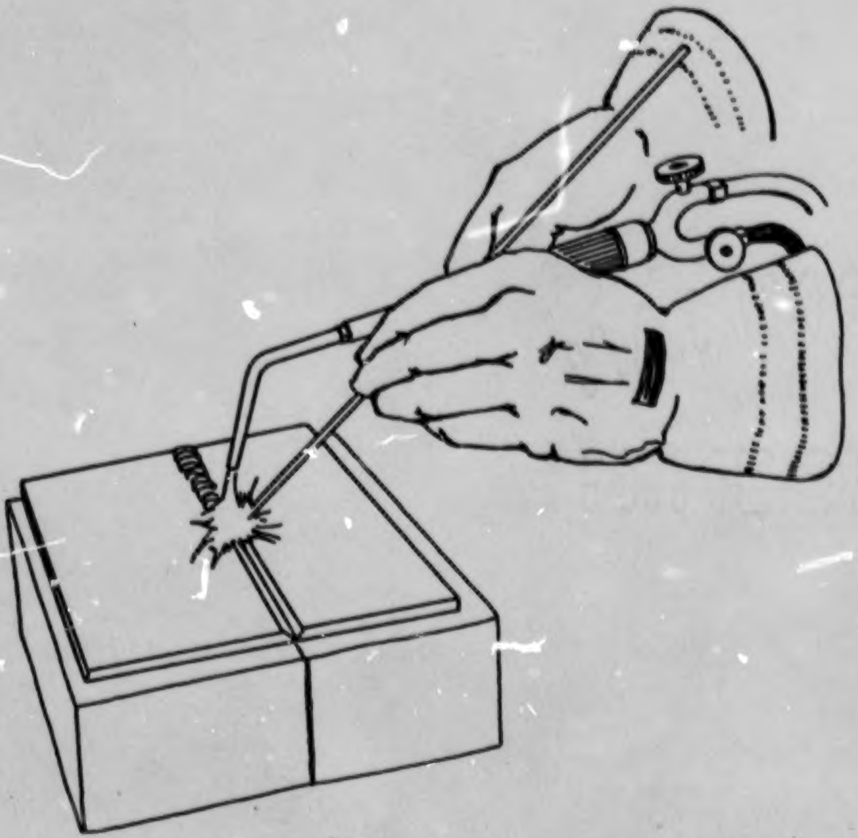
T F 14. Bridge building is a job area that does not require welding.

T F 15. The most important job of a welding instructor is to repair the welding equipment.

Satisfactory Performance ☐
Repeat Exercise ☐
Should Move On ☐

Instructor's Signature Date

Vocational Preparation Curriculum
WELDING



Unit 2

Safety Rules in Gas Welding

Developed by: Hogan Usoro

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Unit 2
Safety Rules in Gas Welding

Safety Rules in Gas Welding

After you study this lesson, you should be able to:

1. Identify an unsafe work area or situation for gas welding.
2. Talk about the safety rules which should be observed in the welding shop or during welding activities.

Show What You Can Do.

Check the statement that fits you best.

1. ☐ **I can do all the tasks above and want my instructor to give me the Practical Exercise.**

SEE YOUR INSTRUCTOR

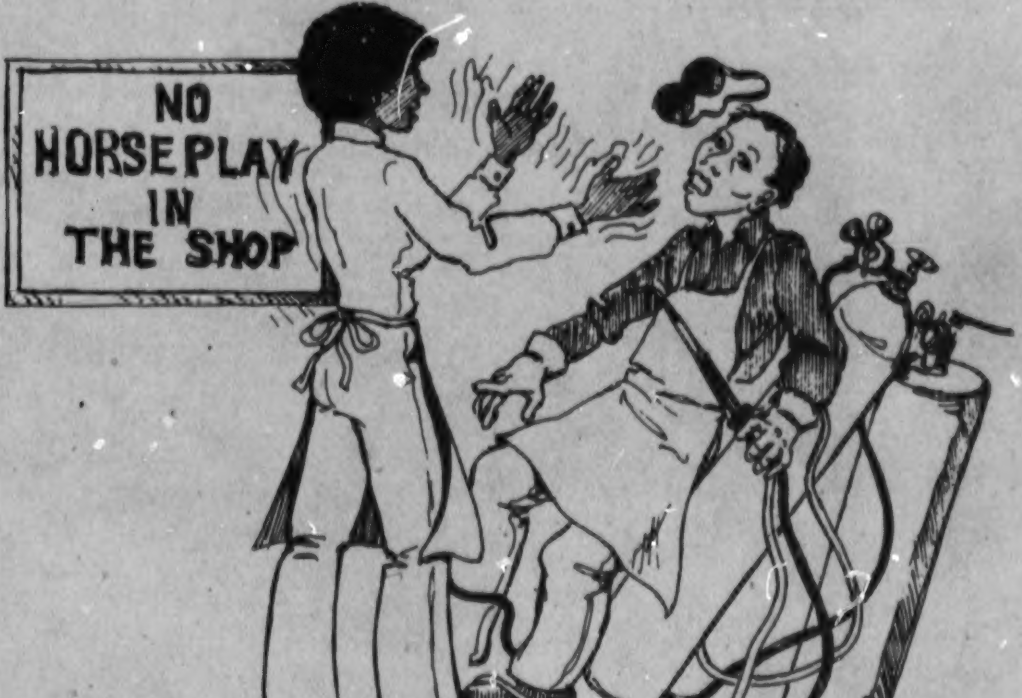
2. ☐ **I want to study the information in this unit before I do the Practical Exercise.**

TURN THE PAGE AND BEGIN

Unit 2
Safety Rules in Gas Welding

Introduction

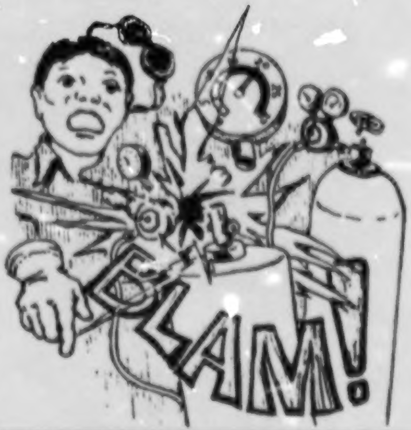
The most important thing to remember when doing gas welding is SAFETY. You must wear proper safety equipment and observe certain safety rules while welding with gas equipment. Training you to observe safety rules will help you to prevent accidents in the shop or on your job. Accidents can be very costly and you must prevent them from happening. The picture below shows the result of not obeying a welding safety rule.



In this lesson, you will learn about more safety rules in gas welding.

TURN TO NEXT PAGE

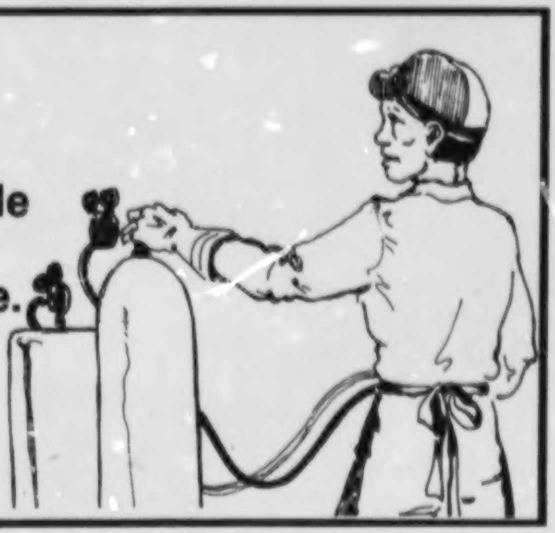
Unit 2
Safety Rules in Gas Welding



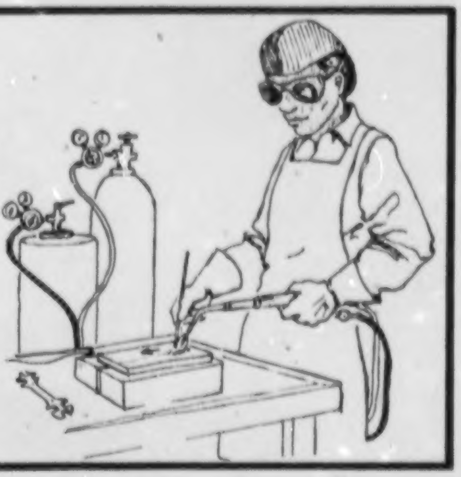
NEVER exceed 15 pounds per square inch (PSI) on the acetylene working gauge.

ALWAYS set the acetylene working pressure to match torch tip size and metal thickness.

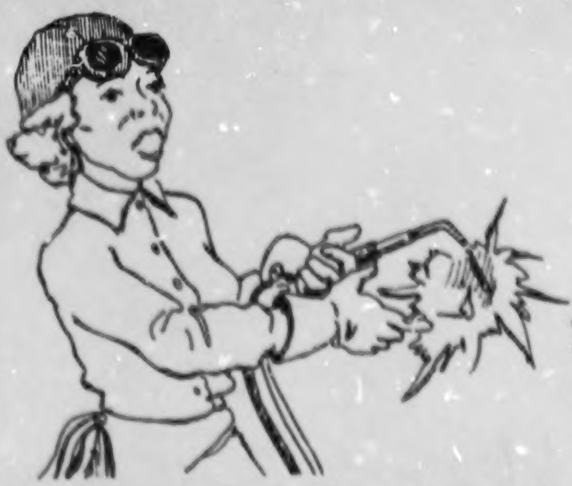
ALWAYS stand to one side of the cylinder while opening the cylinder valve.



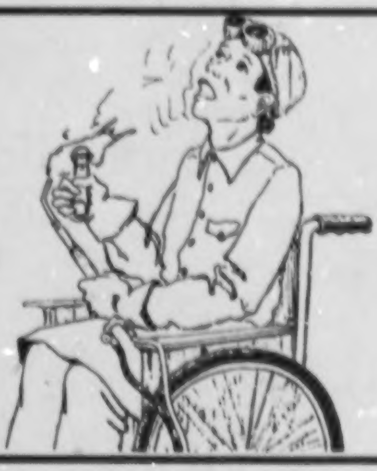
ALWAYS wear safety goggles when you light a torch and when you weld.



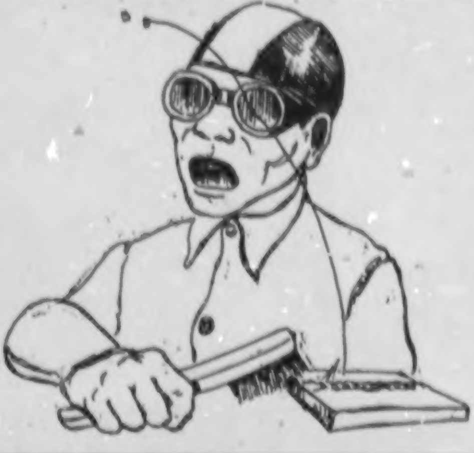
Safety Rules in Gas Welding



NEVER light a welding torch with a match because you may burn yourself in the process.



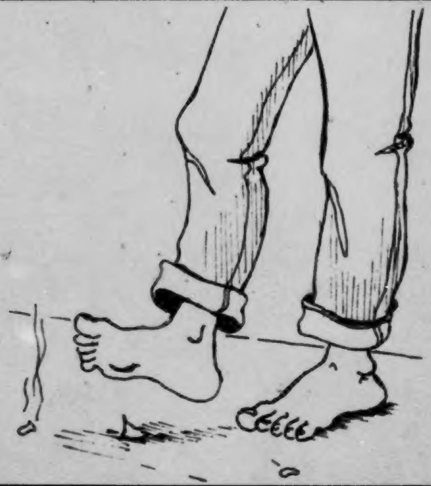
ALWAYS light the torch with its tip pointing downward or toward the top of the bench.



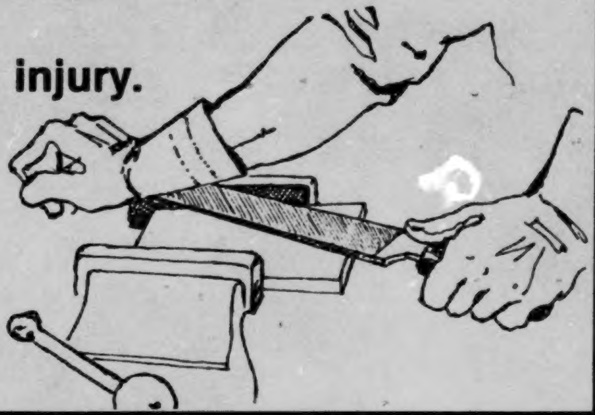
NEVER clean the weld beads without wearing your safety goggles.

Safety Rules in Gas Welding

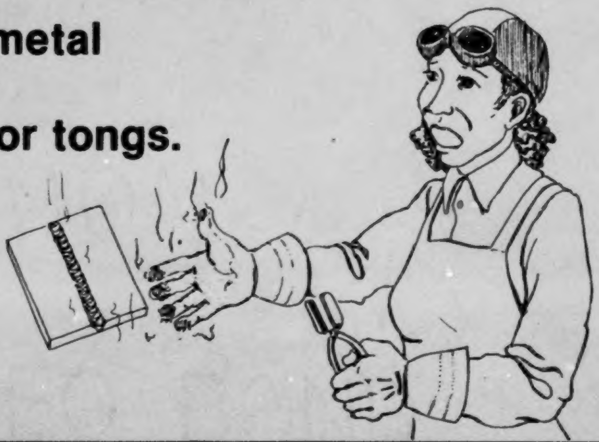
NEVER walk on the welding floor with bare feet.



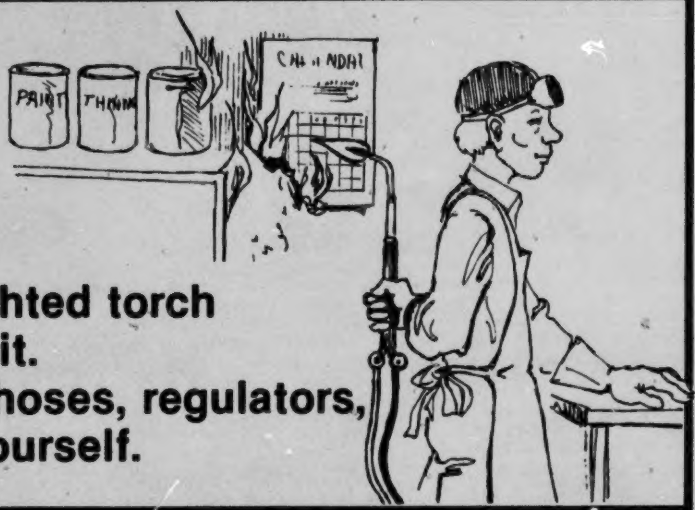
Secure and file small work in a vise.
This will help prevent injury.



NEVER handle hot metal with your fingers.
Use a pair of pliers or tongs.

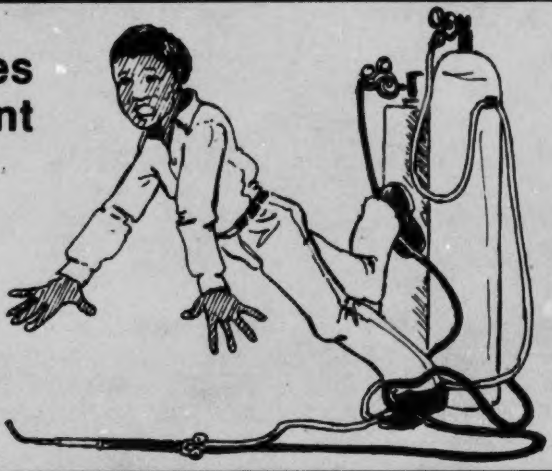


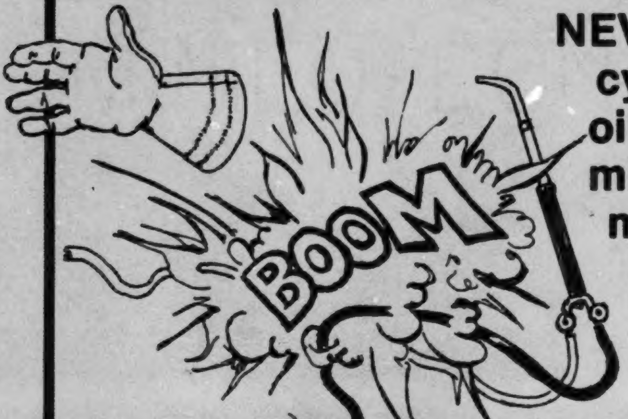
Safety Rules in Gas Welding



ALWAYS keep a lighted torch where you can see it. Point it away from hoses, regulators, other people and yourself.

ALWAYS coil the hoses after welding to prevent tripping and falling.





NEVER operate the oxygen cylinder or regulator with oily or greasy gloves. The mixture of oil and oxygen may cause an explosion.

SEE YOUR INSTRUCTOR

Unit 2
Safety Rules in Gas Welding

Practical Exercise Performance Checklist

Student's Name: ______________________________________

True - False Questions:
Circle "T" if the statement is "True" and an "F" if it is "False."

T F 1. It is a good practice to wear proper safety equipment before you begin to weld.

T F 2. It is always necessary to report accidents to your instructor.

T F 3. A match stick can be used in the place of a sparklighter to light a welding torch.

T F 4. You need to wear safety goggles while wire brushing weld beads or base metals.

T F 5. It is not safe to set the acetylene cylinder gauge to more than 15 pounds per square inch.

T F 6. Stand to one side while opening the oxy-acetylene cylinder valves.

T F 7. You may remove your goggles while lighting the torch so that you can see what type of flame is produced.

T F 8. It is unsafe for you to walk without proper shoes on the welding floor.

T F 9. Do not engage in horseplay in the welding shop.

T F 10. When cleaning or filing a small piece of metal, secure it in a vise.

T F 11. Gloves are safer to use than pliers when moving hot metals.

T F 12. Do not point a torch flame at the hoses.

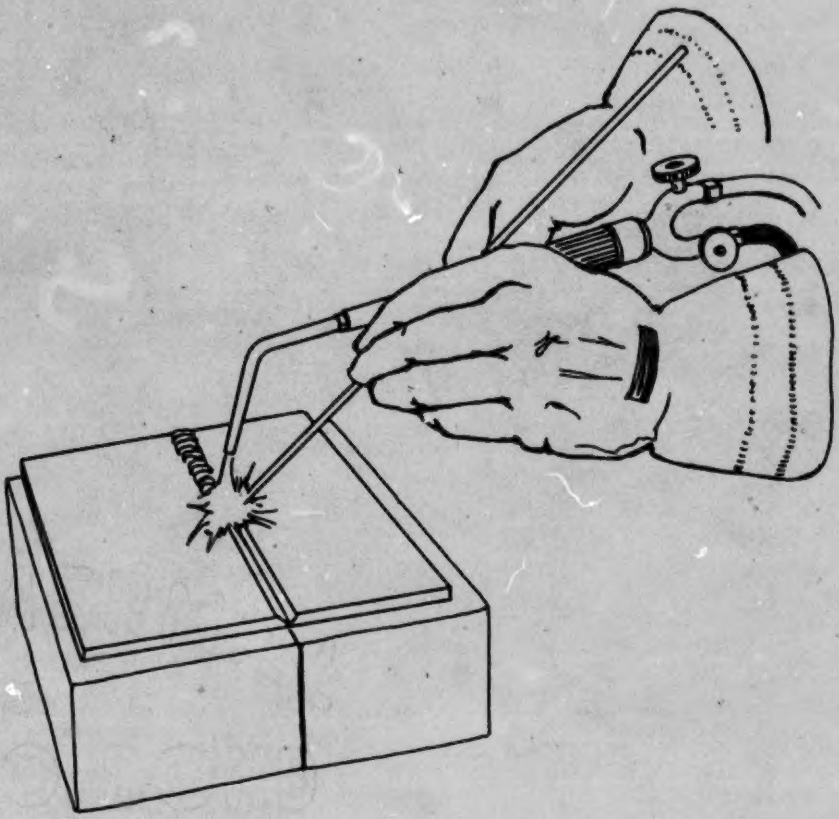
T F 13. It is always safe to coil the hoses after you complete any gas welding exercise.

T F 14. When your hands are oily, you must never touch the oxygen regulator or working gauge.

Satisfactory Performance ☐
Repeat Exercise ☐
Should Move On ☐

Instructor's Signature ____________ Date ________

Vocational Preparation Curriculum
WELDING



Unit 3

Lighting and Adjusting a Welding Torch

Developed by: Hogan Usoro

PRACTICAL ARTS AND VOCATIONAL-TECHNICAL EDUCATION
IMI
INSTRUCTIONAL MATERIALS LABORATORY
UNIVERSITY OF MISSOURI-COLUMBIA

Unit 3

Lighting and Adjusting a Welding Torch

Lighting and Adjusting a Welding Torch

After you study this lesson, you should be able to:

1. Light a welding torch.
2. Adjust a welding torch to a neutral flame.
3. Shut off the welding torch.

Show What You Can Do

Check the statement that fits you best.

1. ☐ I can do all the tasks above and want my instructor to give me the Practical Exercise.

SEE YOUR INSTRUCTOR

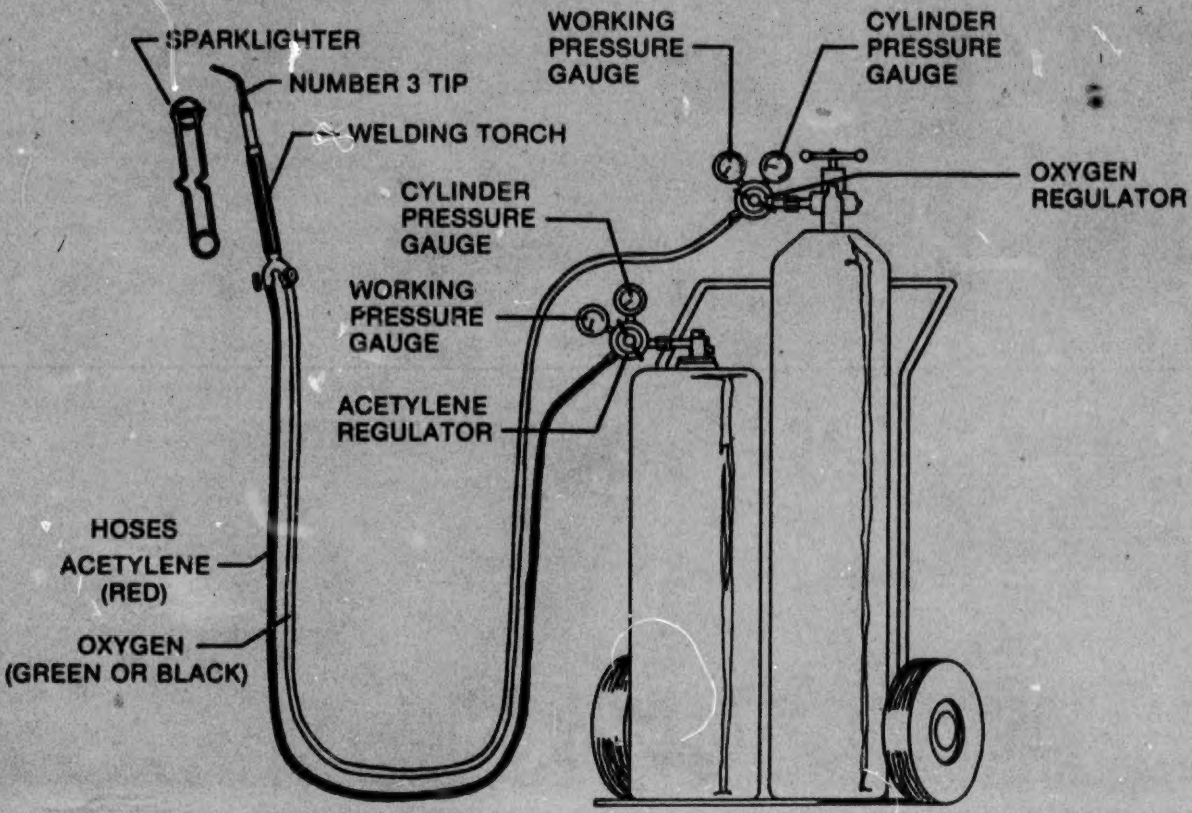
2. ☐ I want to study the information in this unit before I do the Practical Exercise.

TURN THE PAGE AND BEGIN

Unit 3
Lighting and Adjusting a Welding Torch

Introduction

Gas welding is the joining of two metals by heating with a gas flame. Oxygen and Acetylene are the two gasses which provide the flame. To gas weld you must know how to light and adjust a welding torch. In this unit you will learn how to light and adjust a welding torch for gas welding.


SPARKLIGHTER
NUMBER 3 TIP
WELDING TORCH
WORKING PRESSURE GAUGE
CYLINDER PRESSURE GAUGE
OXYGEN REGULATOR
CYLINDER PRESSURE GAUGE
WORKING PRESSURE GAUGE
ACETYLENE REGULATOR
HOSES
ACETYLENE (RED)
OXYGEN (GREEN OR BLACK)

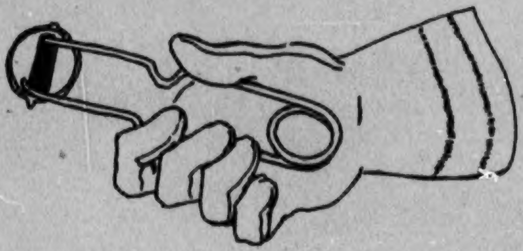
TURN TO NEXT PAGE

Unit 3

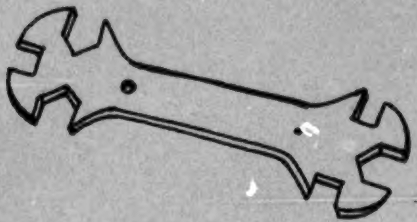
Lighting and Adjusting a Welding Torch

A. Tools, Materials and Equipment for Lighting and Adjusting a Welding Torch.

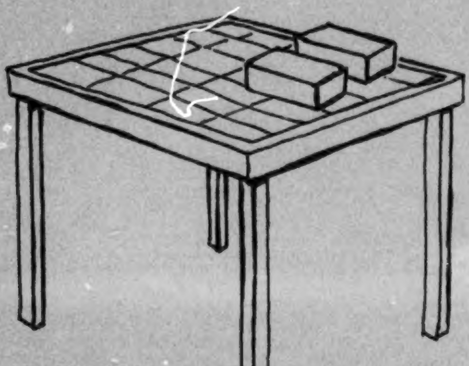
1. **SPARKLIGHTER:** Used to light a welding torch.



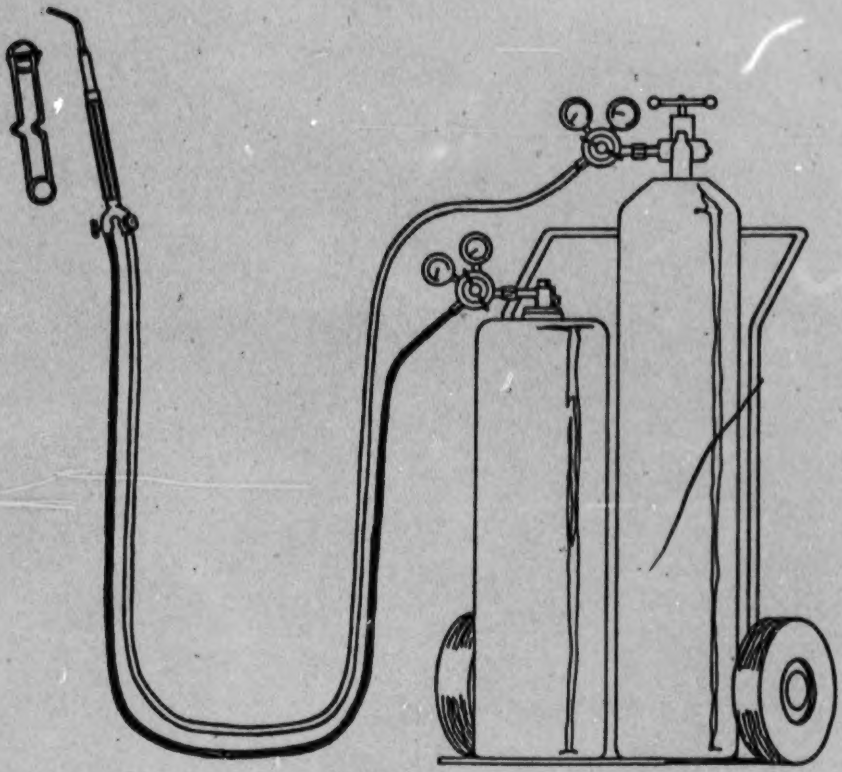
2. **TORCH TIP WRENCH:** Used to attach and remove welding tips.



3. **WELDING TABLE:** Used to support metals for welding.

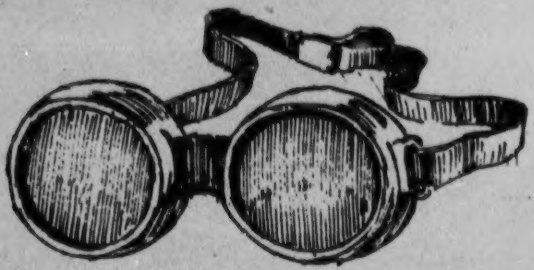


4. **GAS WELDING EQUIPMENT:** Provides gasses for the flame used to join or cut metals.

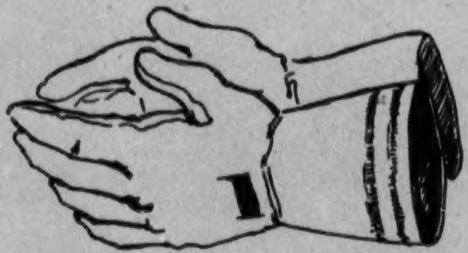


SAFETY EQUIPMENT:

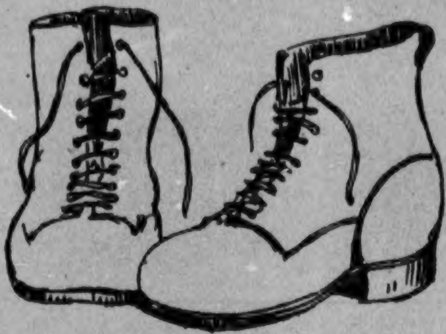
GOGGLES: Used as eye protection when welding.



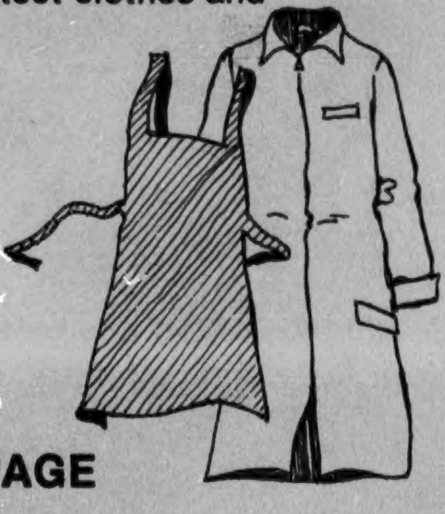
THICK GLOVES: Worn to protect hands from sharp edges and hot metals.



HEAVY SHOES: Worn to protect legs and feet from sharp points and hot metal.



APRON OR SHOP COAT: Worn to protect clothes and body from injury and dirt.



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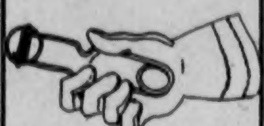
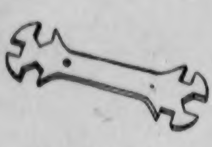
B. Steps for Lighting and Adjusting a Welding Torch.

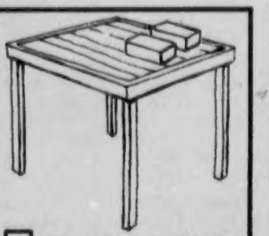
1. Find and Check Off the following.



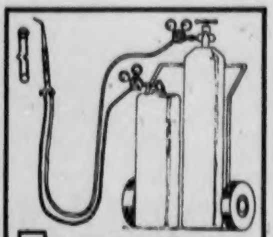
☐ Sparklighter



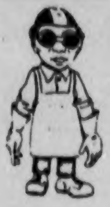
☐ Torch Tip Wrench



☐ Welding Table

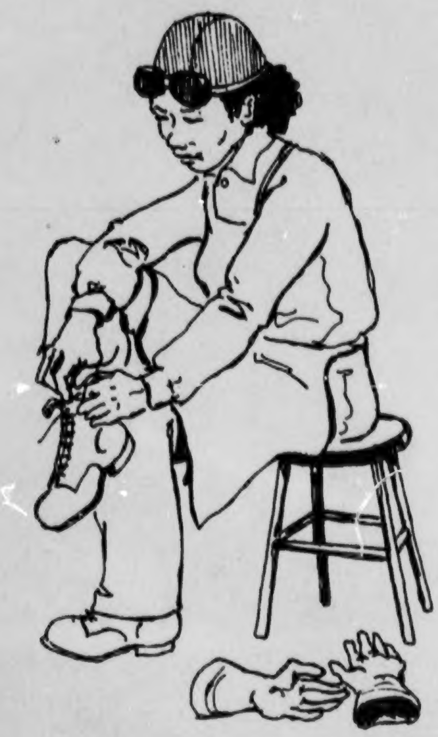


☐ Welding Equip.

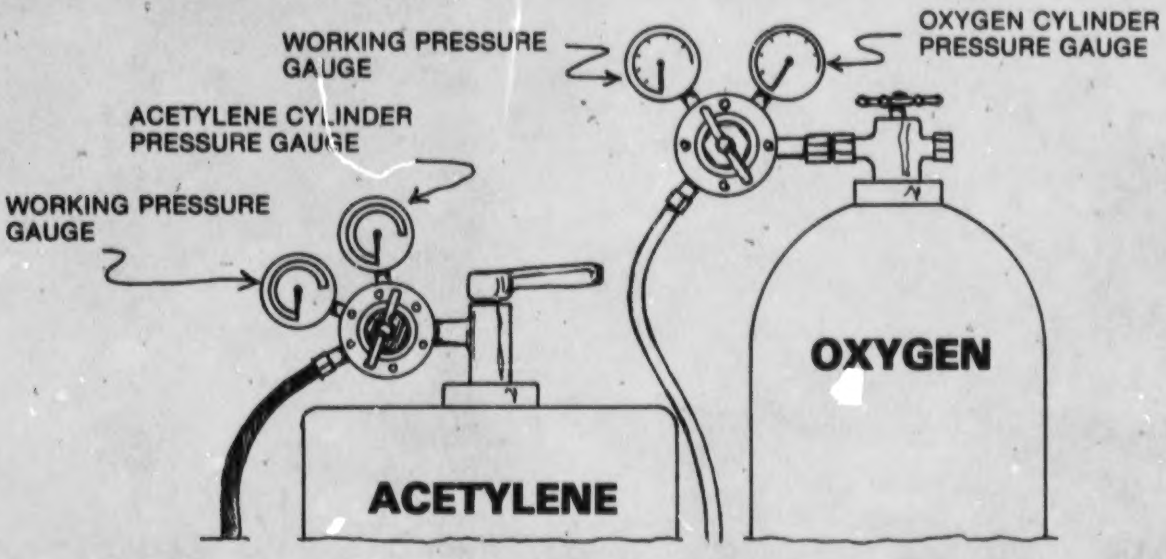


☐ Safety Equip.

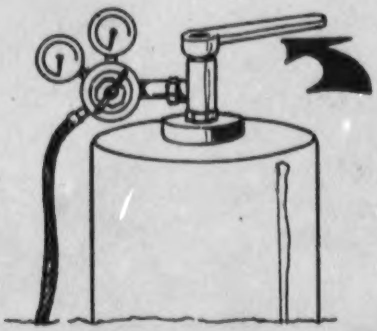
2. Wear proper safety equipment.



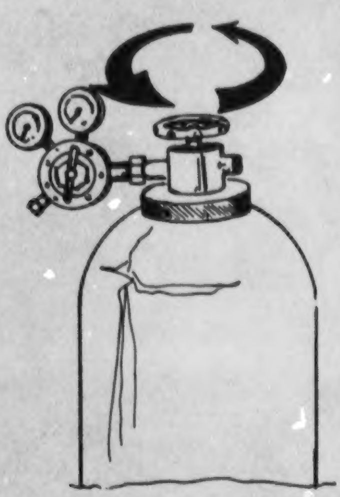
3. Check the gas welding equipment and make sure all gauges read zero.


WORKING PRESSURE GAUGE
OXYGEN CYLINDER PRESSURE GAUGE
ACETYLENE CYLINDER PRESSURE GAUGE
WORKING PRESSURE GAUGE
OXYGEN
ACETYLENE

4. Turn the **acetylene cylinder valve** 1/4 to 1/2 turn to the left.



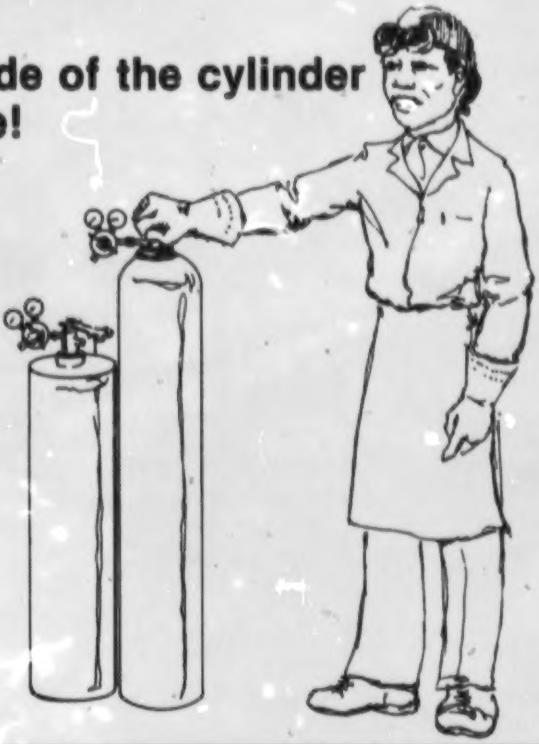
Turn the **oxygen cylinder valve** all the way to the left.



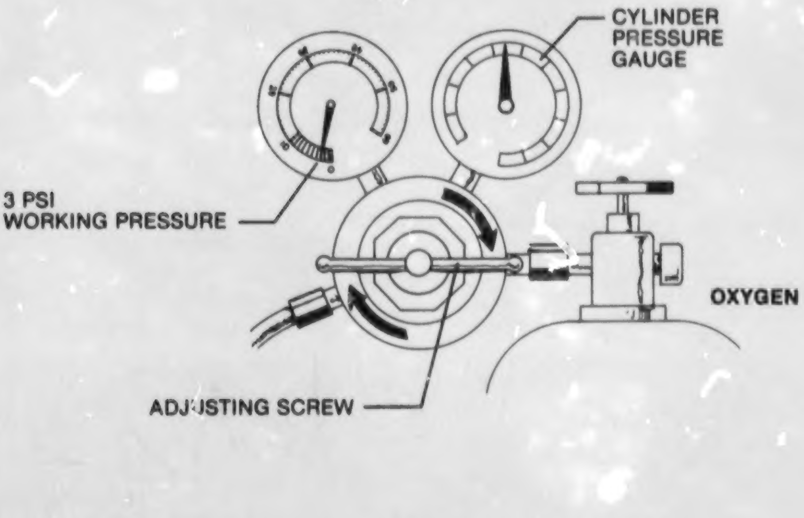
CAUTION!

Always stand to one side of the cylinder when opening the valve!

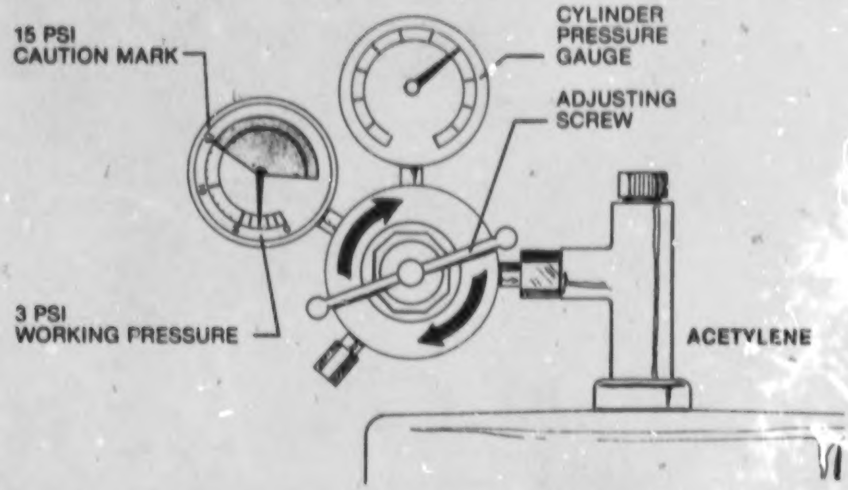
Always
open valves slowly!



5. Set the **oxygen pressure gauge** to three pounds per square inch by turning the **adjusting screw** to the right.


CYLINDER PRESSURE GAUGE
3 PSI WORKING PRESSURE
OXYGEN
ADJUSTING SCREW

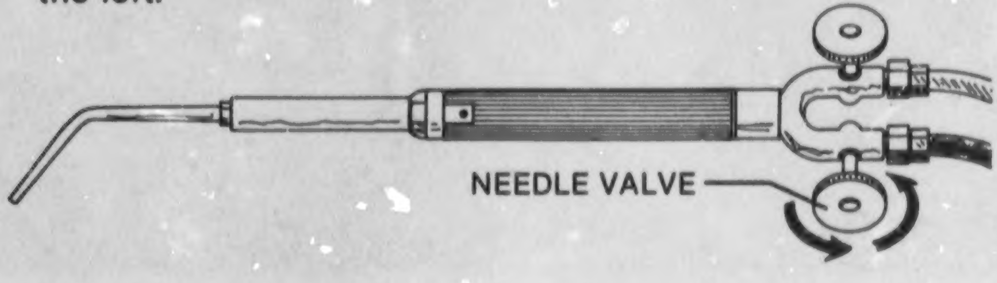
6. Set the **acetylene pressure gauge** to three pounds per square inch by turning the **adjusting screw** to the right.


15 PSI
CAUTION MARK
CYLINDER
PRESSURE
GAUGE
ADJUSTING
SCREW
3 PSI
WORKING PRESSURE
ACETYLENE

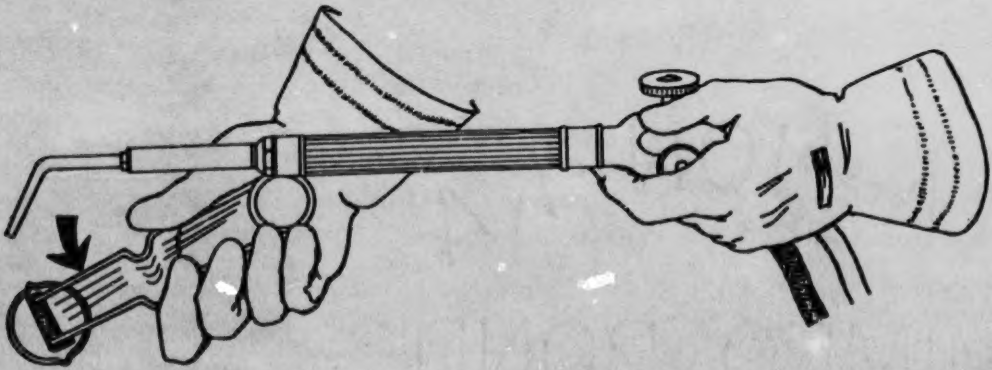
CAUTION!

**NEVER exceed
15 pounds per square inch
on the acetylene
working pressure gauge
because the cylinder can explode!**

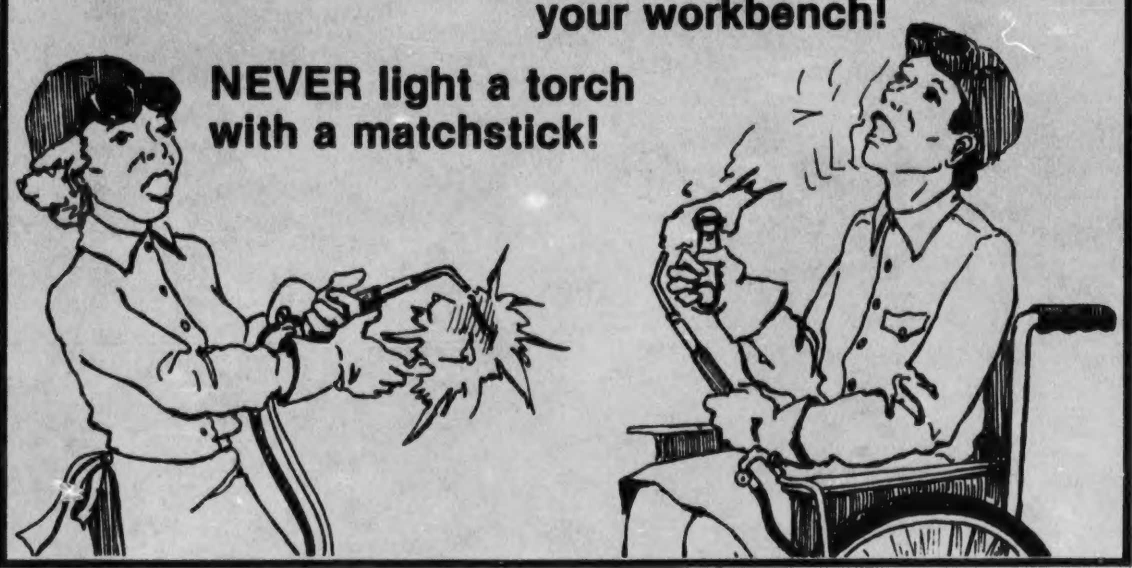
7. Protect your eyes with goggles.
Turn the **acetylene needle valve** on the torch 3/4 of a turn to the left.


NEEDLE VALVE

8. Light the torch with the sparklighter.



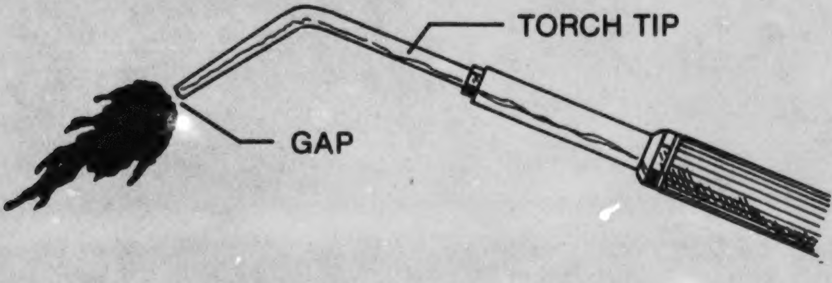
CAUTION!



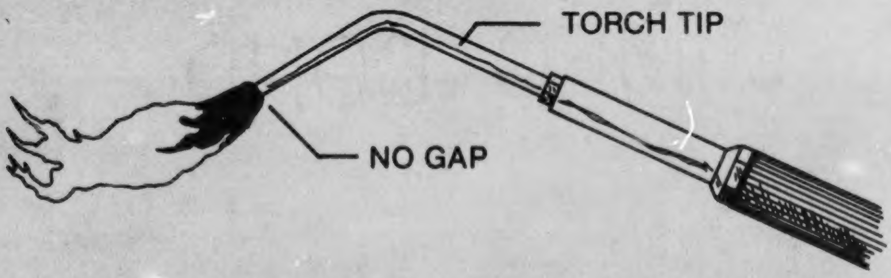
ALWAYS point the torch downward or toward your workbench!

NEVER light a torch with a matchstick!

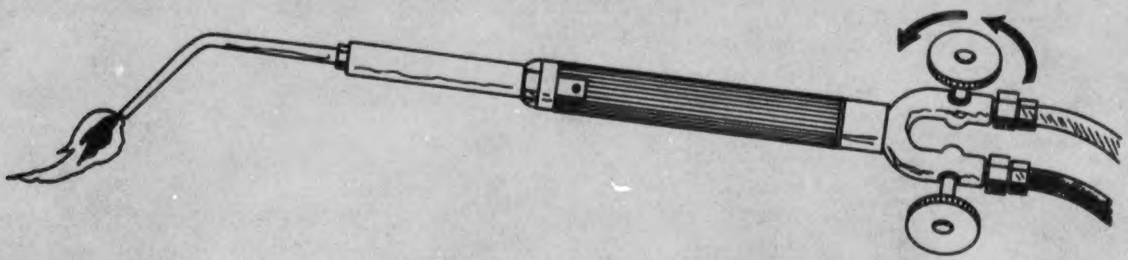
9. Continue to turn the **acetylene needle valve** to the left until the flame jumps from the tip.



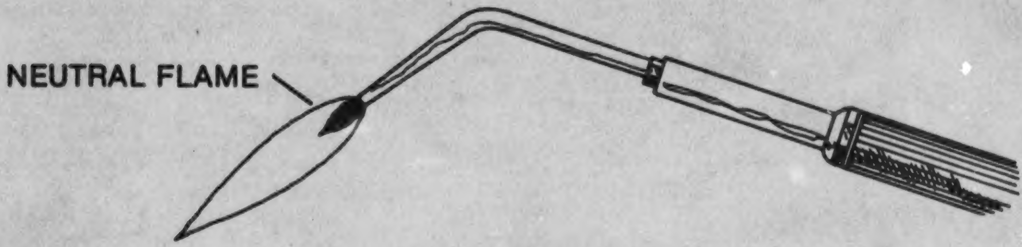
10. Bring the flame back to the torch tip by turning the **acetylene needle valve** slightly to the right.



11. Turn the **oxygen needle valve** to the left until the flame becomes light blue with a bright feather-shaped flame inside.



12. Adjust the **oxygen needle valve** until you obtain a NEUTRAL FLAME. The neutral flame is used in most welding exercises.

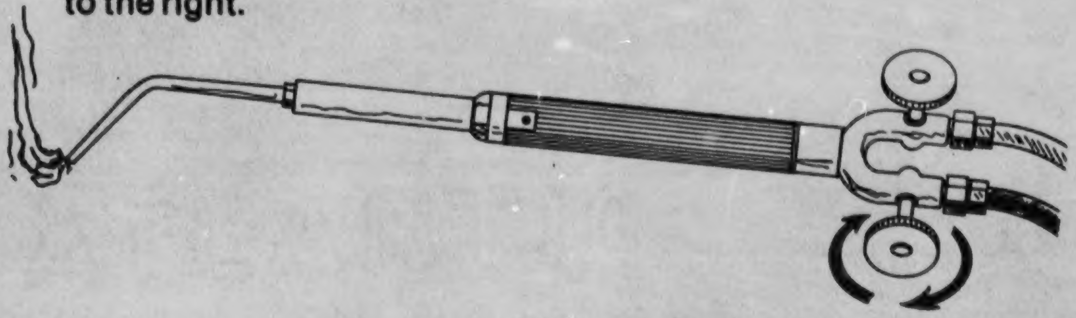


You have now lighted and adjusted a welding torch. Make sure you understand these steps.

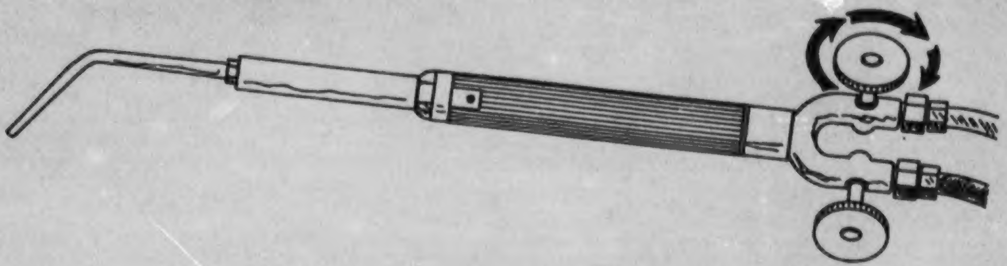
TURN TO NEXT PAGE

C. Steps for Shutting Off the Welding Torch.

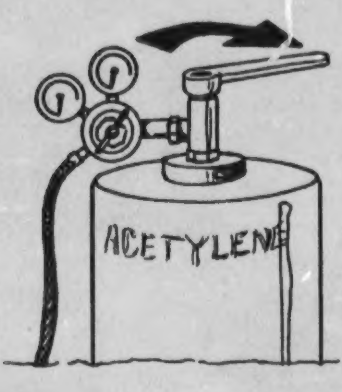
1. Shut off the acetylene gas by turning the **acetylene needle valve** to the right.

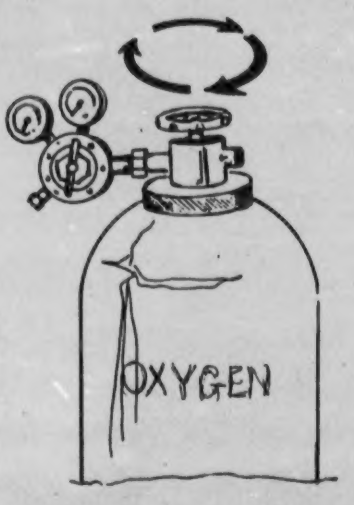


2. Shut off the oxygen by turning the **oxygen needle valve** to the right.



3. Close the **acetylene cylinder valve** by turning it to the right with a wrench.

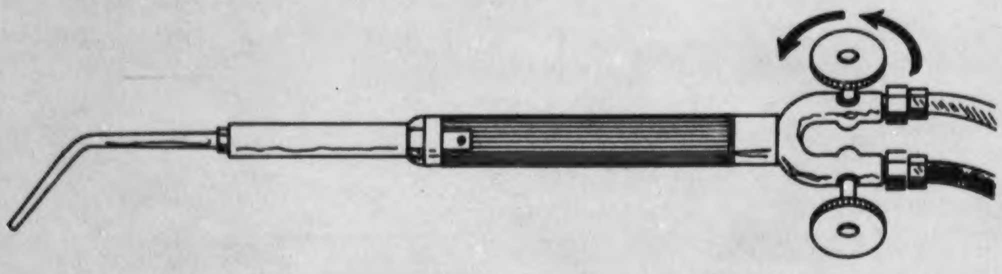




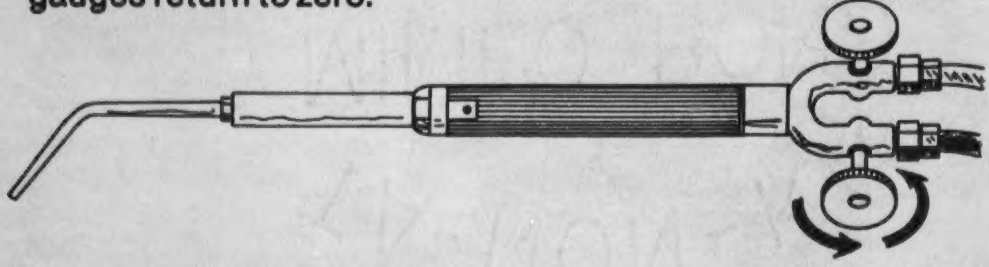
Close the **oxygen cylinder valve** by also turning it to the right.

Now drain off any extra oxygen or acetylene gas still in the hoses.

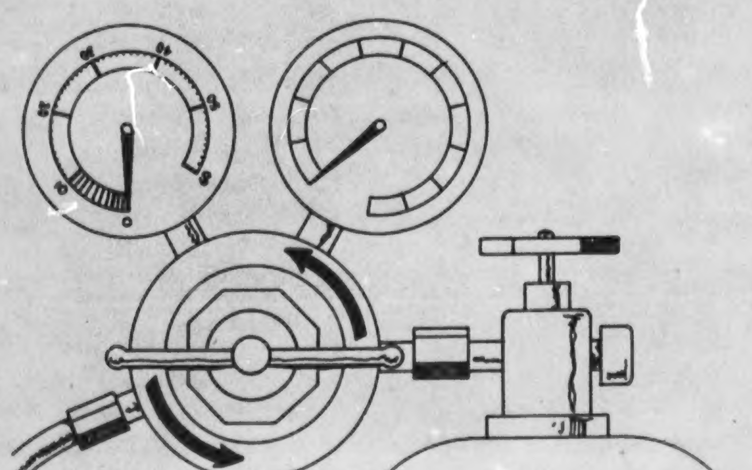
4. Turn the **oxygen needle valve** back to the left to drain the oxygen. Hold up the torch until the pointers on both oxygen gauges return to zero.



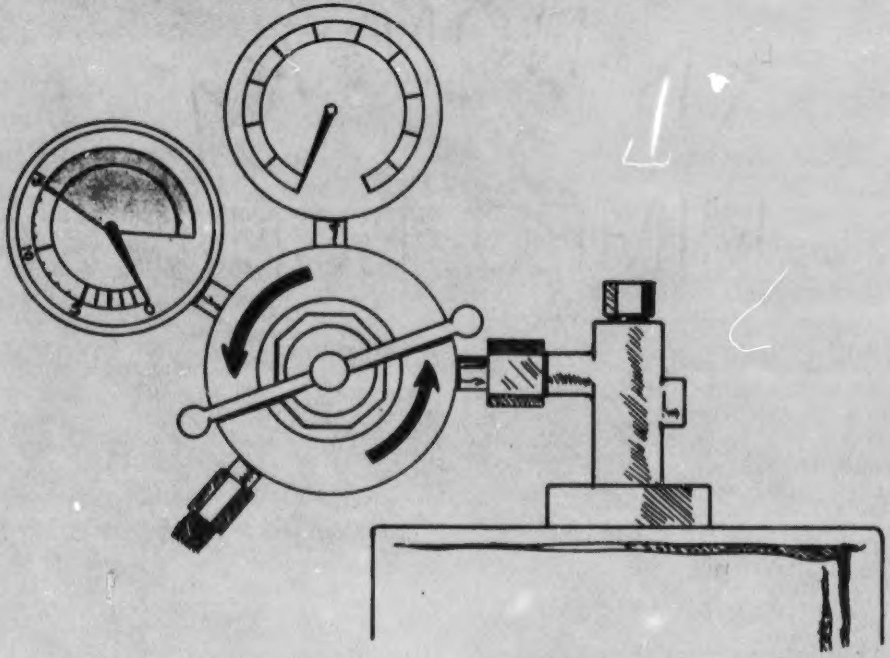
5. Turn the **acetylene needle valve** back to the left to drain the acetylene gas.
   Hold up the torch again until the pointers on both acetylene gauges return to zero.



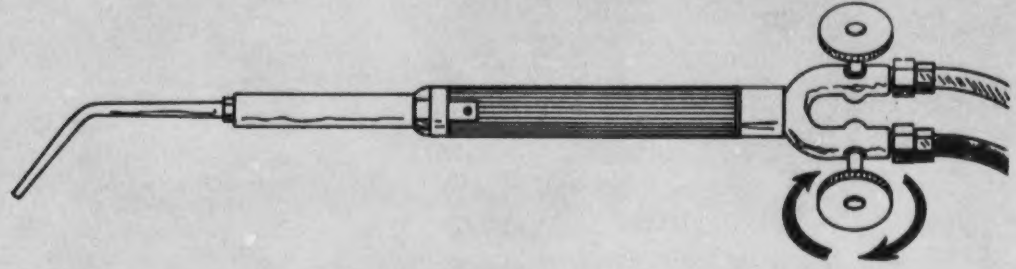
6. Turn the **oxygen regulator adjusting screw** to the left until the **adjusting screw** becomes loose.



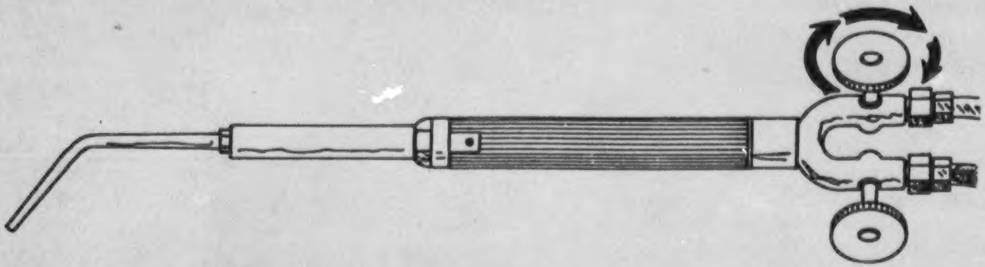
7. Turn the **acetylene regulator adjusting screw** to the left until this **adjusting screw** becomes loose.



8. Close the **acetylene needle valve** by turning it back to the right.



9. Close the **oxygen needle valve** by turning it back to the right.



You have now lighted, adjusted and shut off a gas welding torch. Practice this skill.

SEE YOUR INSTRUCTOR

Unit 3
Lighting and Adjusting a Welding Torch

Tools and Materials Identification Exercise

Match the words with the correct objects provided below:

______ A. Sparklighter

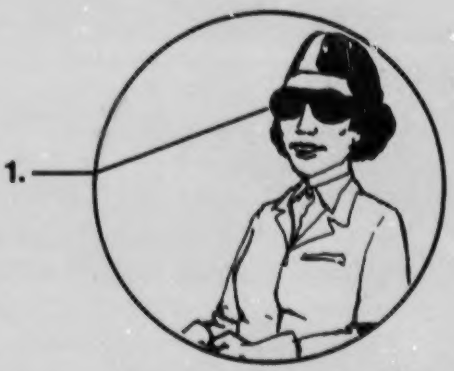
______ B. Welding Tip

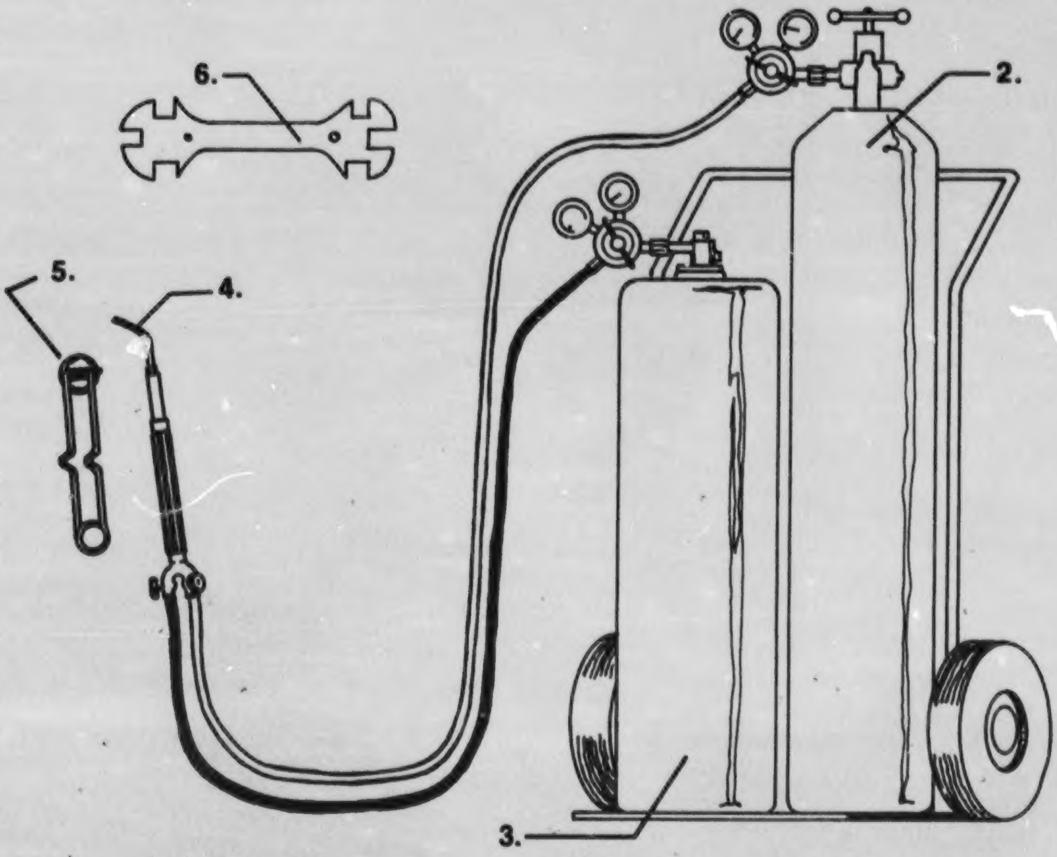
______ C. Safety Goggles

______ D. Oxygen Cylinder

______ E. Acetylene Cylinder

______ F. Torch Tip Wrench





Unit 3
Lighting and Adjusting a Welding Torch

Practical Exercise Performance Checklist

The student ______________________ successfully performed the following tasks:

Tasks	Yes	No	Comments
1. Identified:			
a. Sparklighter			
b. Welding tip			
c. Safety equipment			
d. Oxygen cylinder			
e. Acetylene cylinder			
f. Torch tip wrench			
2. Wore proper safety equipment			
3. Checked the gas welding equipment before turning it on			
4. Properly opened the acetylene cylinder valve (1/4 to 1/2 turn)			
5. Properly opened the oxygen cylinder valve (all the way to the left)			
6. Observed the safety habit of standing to one side of the equipment while opening the valve			
7. Correctly set the working pressure on the oxygen gauge			
8. Correctly set the working pressure on the acetylene gauge			
9. Correctly opened the acetylene needle valve			
10. Lighted the torch with a sparklighter			
11. Held the lighted torch in a safe manner			
12. Turned on acetylene until flame jumped away from torch tip			

Tasks	Yes	No	Comments
13. Turned the acetylene needle valve to bring flame back to torch tip			
14. Opened the oxygen needle valve to the left until a light blue feather-shaped flame was obtained			
15. Correctly adjusted the oxygen needle valve to obtain a neutral flame			
16. Turned off the acetylene needle valve			
17. Turned the oxygen needle valve			
18. Closed the acetylene cylinder valve			
19. Closed the oxygen cylinder valve			
20. Opened the oxygen needle valve to drain oxygen			
21. Opened the acetylene needle valve to drain the acetylene gas			
22. Released the oxygen regulator adjusting screw			
23. Released the acetylene regulator adjusting screw			
24. Closed the acetylene needle valve			
25. Closed the oxygen needle valve			

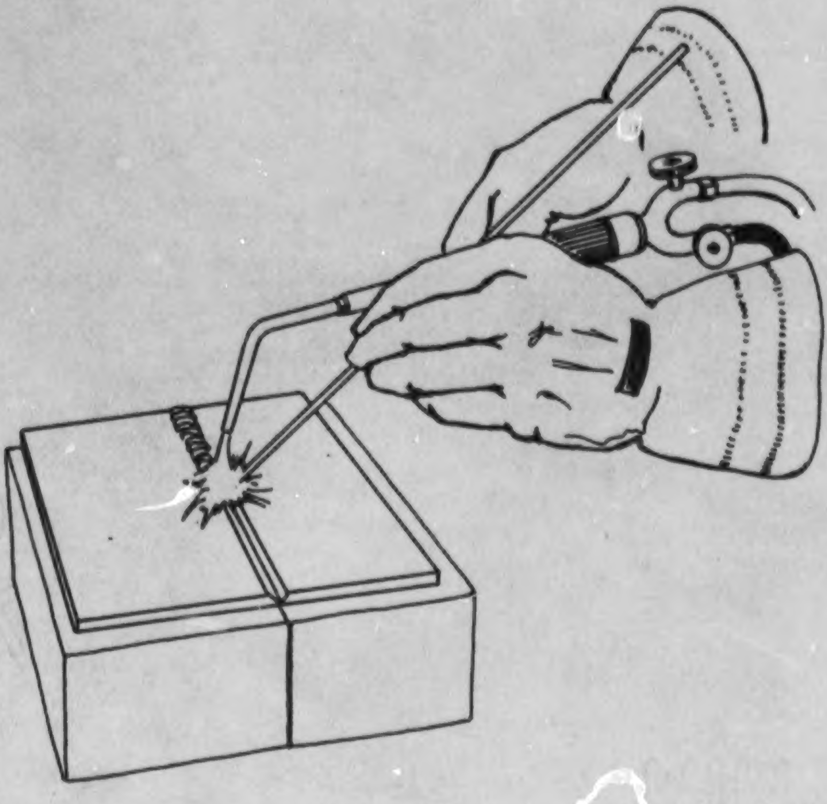
Satisfactory Performance ☐

Should Move On ☐

Repeat Exercise ☐

Instructor's Signature ____________ Date ________

Vocational Preparation Curriculum
WELDING



Unit 4

Running a Bead without Filler Rod

Developed by: Hogan Usoro

PRACTICAL ARTS
AND
VOCATIONAL-TECHNICAL
EDUCATION
IML
INSTRUCTIONAL MATERIALS LABORATORY
UNIVERSITY OF MISSOURI-COLUMBIA

Unit 4
Running a Bead without Filler Rod

Running a Bead without Filler Rod

After you study this lesson, you should be able to:

1. Identify tools and materials used in running beads without a filler rod.
2. Run beads without a filler rod.

Show What You Can Do.

Check the statement that fits you best.

1. ☐ **I can do all the tasks above and want my instructor to give me the Practical Exercise.**

SEE YOUR INSTRUCTOR

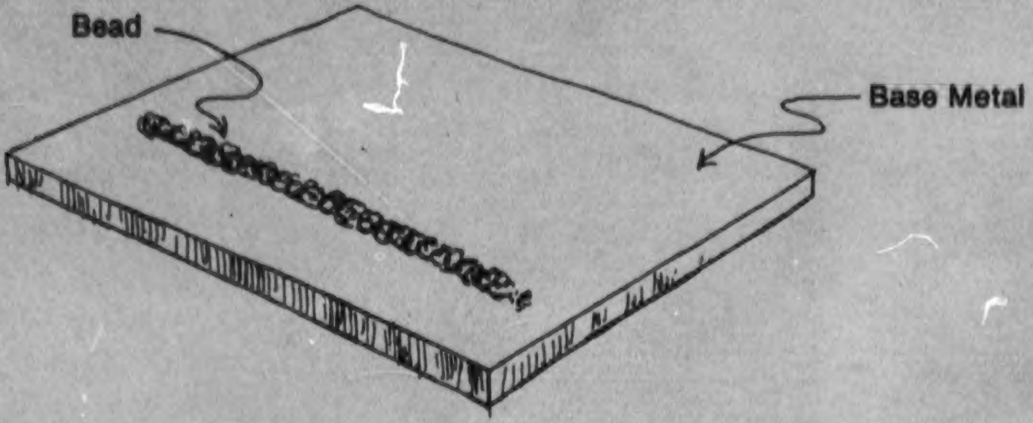
2. ☐ **I want to study the information in this unit before I do the Practical Exercise.**

TURN THE PAGE AND BEGIN

Unit 4
Running a Bead without Filler Rod

Introduction

In the last unit you learned to light and adjust a welding torch. In this unit, you will learn to run a bead with the welding torch. A bead is a layer of melted metal laid on the base metal.



In gas welding you can run a bead with or without a filler rod. In this lesson, you will use only the welding torch flame to run the bead. This is an important skill for you to learn first.

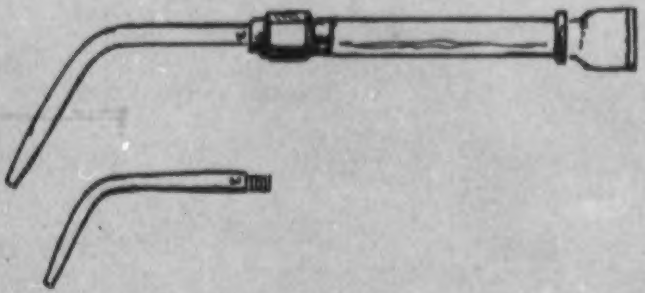
It is hoped that you will find this lesson interesting. Now let us begin.

TURN TO NEXT PAGE

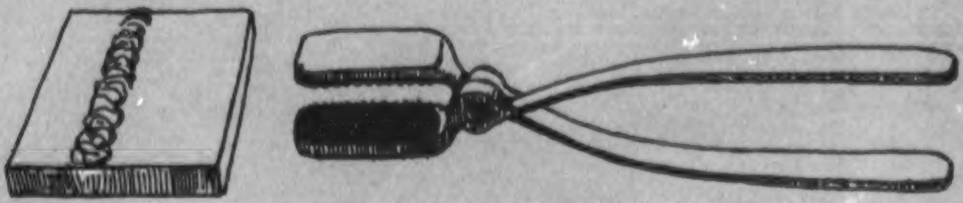
Unit 4
Running a Bead without Filler Rod

A. Tools, Materials and Equipment for Running a Bead without Filler Rod.

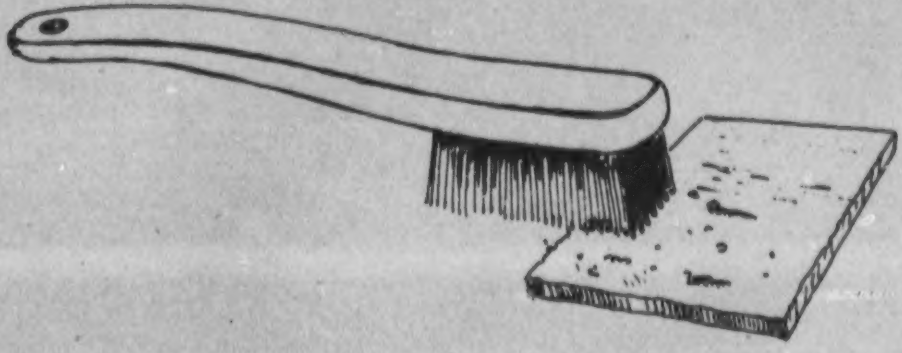
1. **WELDING TIP:** Attached to the welding torch to carry the flame.



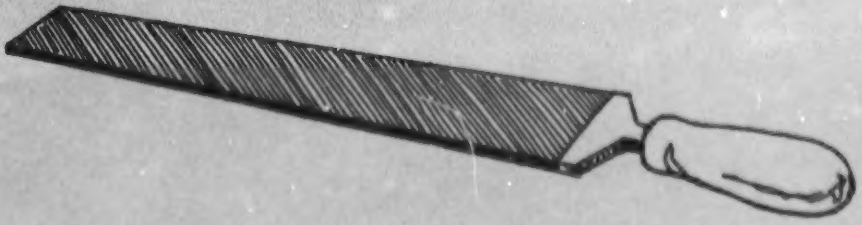
2. **PLIERS:** Used to hold hot metal.



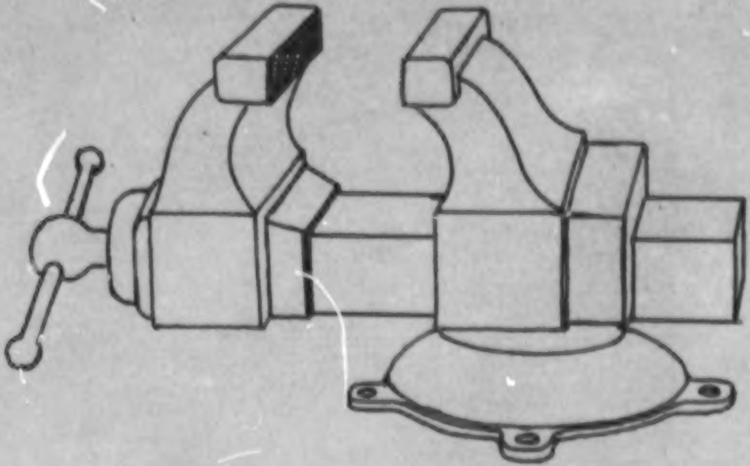
3. **WIRE BRUSH:** Used to clean metal bead or rust from metal.



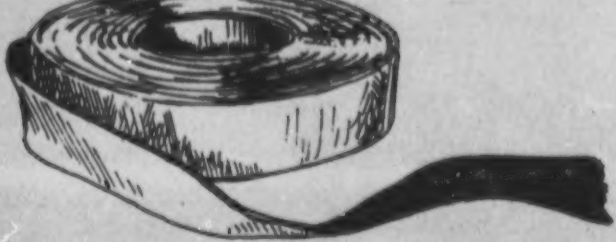
4. **METAL FILE:** Used to smooth sharp edges of a cut metal piece.



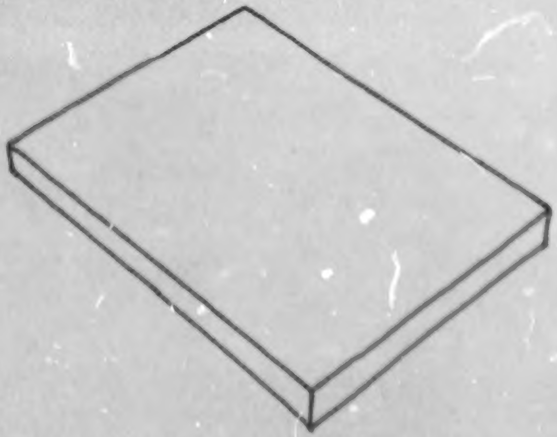
5. **VISE:** Used to hold a metal piece in place for cutting and cleaning.



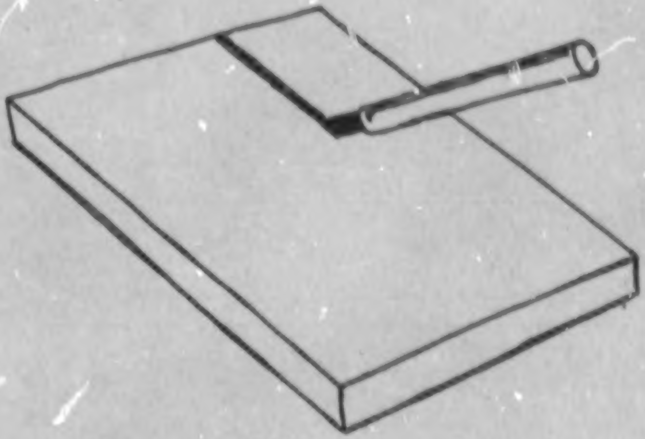
6. **EMERY CLOTH:** Used to clean metal surface before welding.



7. **BASE METAL:** Metal to be welded or metal on which you run the bead.



8. **SOAPSTONE:** Used to draw lines on base metal to guide welding exercise.



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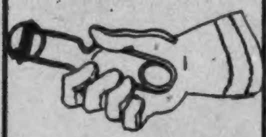
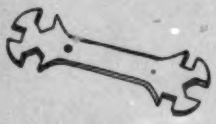
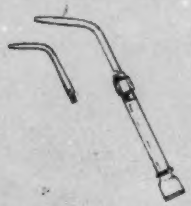
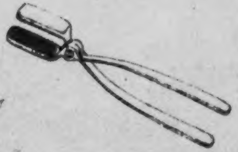
B. Steps for Running a Bead without Filler Rod.

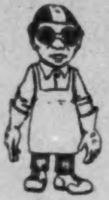
1. Find and Check Off the following:

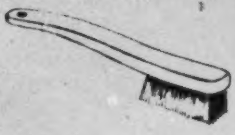

☐ Sparklighter

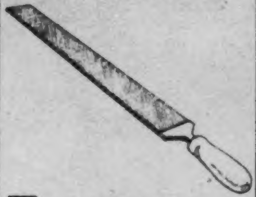

☐ Torch Tip Wrench

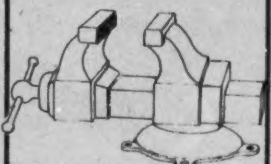

☐ Welding Tip

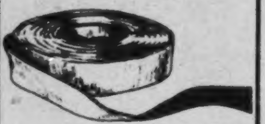

☐ Pliers

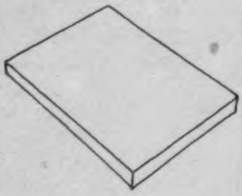

☐ Safety Equip.

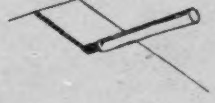

☐ Wire Brush


☐ Metal File

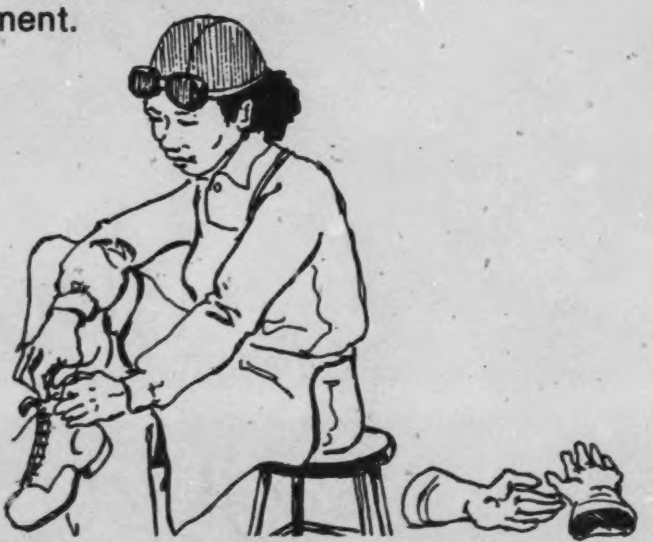

☐ Vise


☐ Emery Cloth

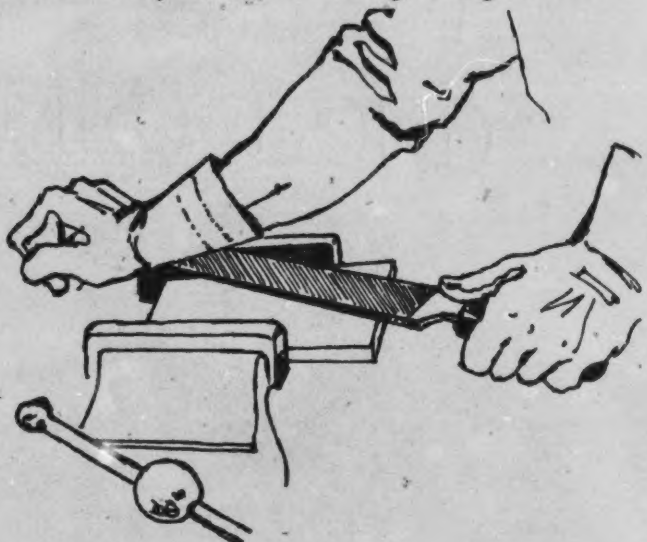

☐ Base Metal


☐ Soapstone

2. Wear proper safety equipment.



3. Obtain a base metal 4 inches wide and 6 inches long. Secure this piece in a vise and file away sharp or rough edges.

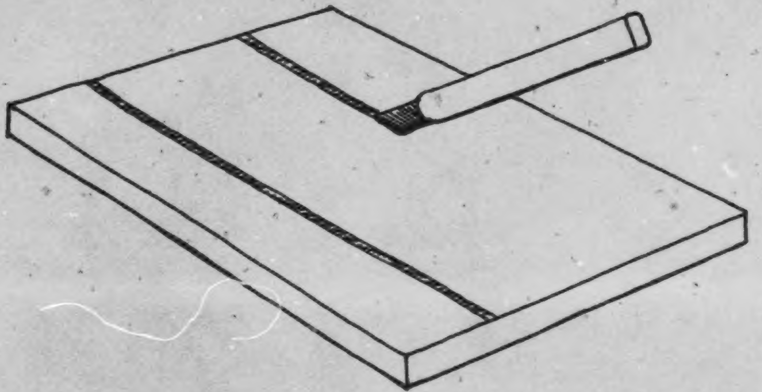


Smooth the surface with emery cloth.

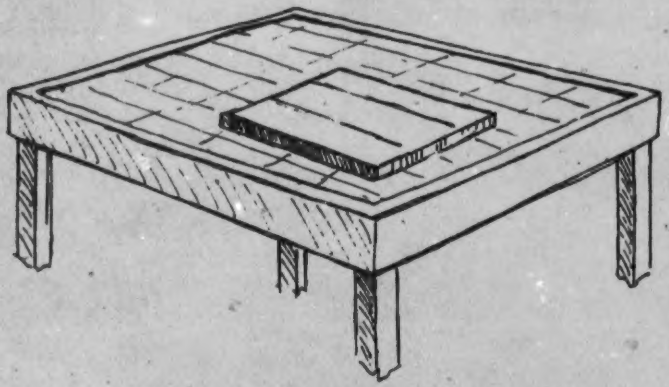
NOTE!

Always clean the metal surface properly in order to have a good surface for welding.

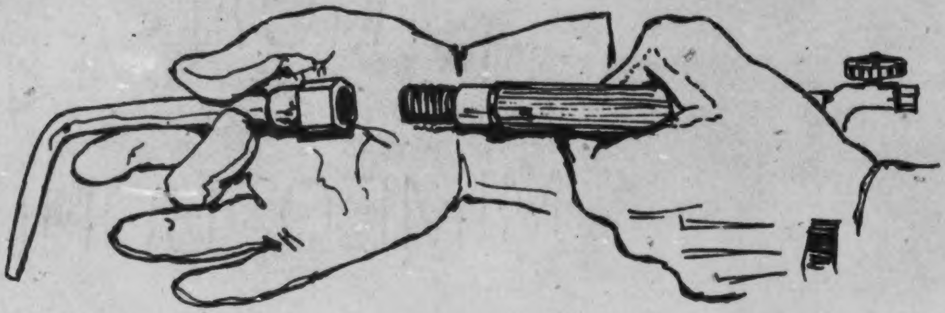
4. Draw two lines with soapstone on the metal surface.



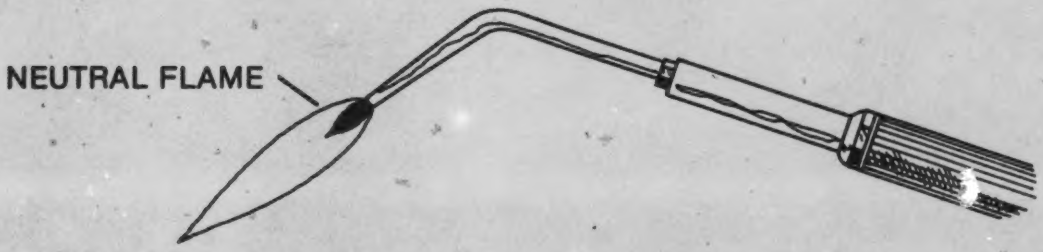
5. Place the base metal in position on the welding table.



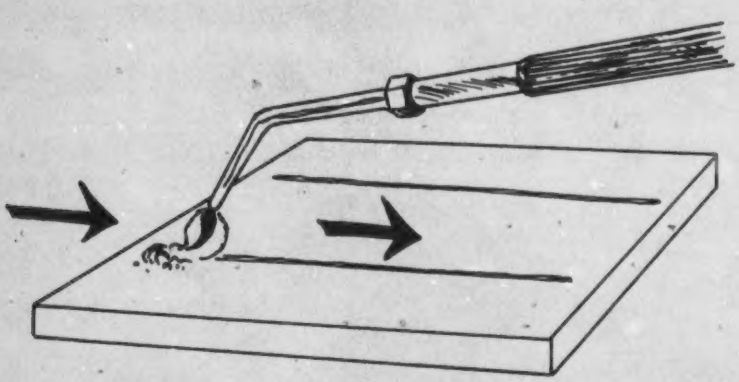
6. Select and attach the Number 3 welding torch tip. Tighten it with the torch tip wrench.



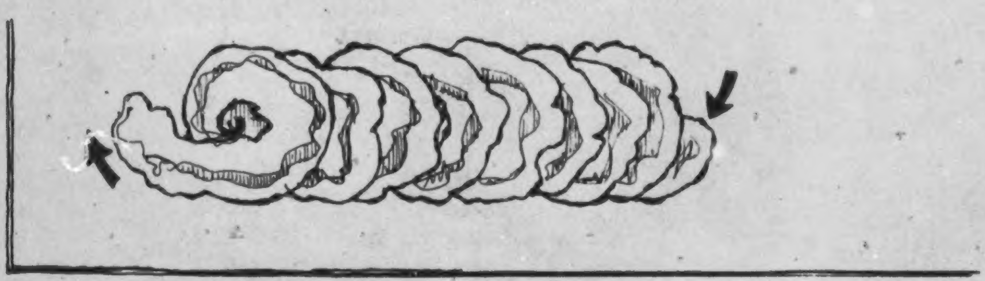
7. Light and adjust the welding torch to a neutral flame.



8. Hold the torch to the base metal. Heat the metal on one spot until a puddle forms. A puddle is a pool of melted metal.



9. Move the torch slowly in small circles along the soapstone line melting the metal surface and forming a puddle. Stop the weld about 1/2 inch from the edge of the base metal.



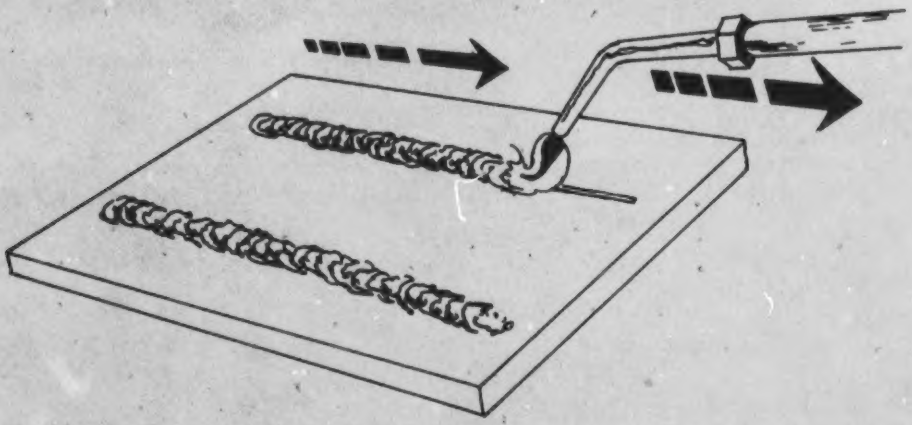
NOTE!

DO NOT move the torch too quickly or you will produce narrow and pointed beads.

DO NOT move the torch too slowly or the flame will melt a hole through the metal.

DO NOT worry if you have trouble running a bead the first time. Practice will improve your skill.

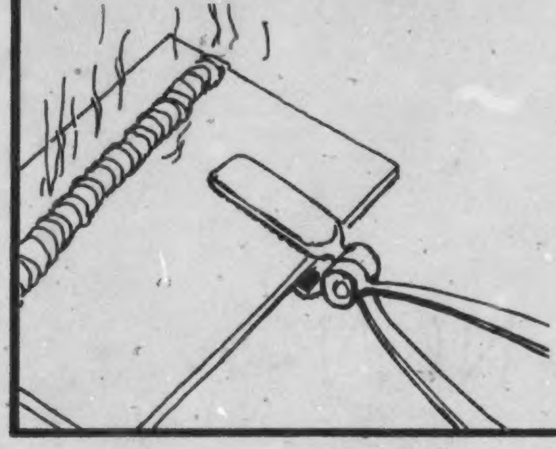
10. Run beads on the second soapstone line. Stop about 1/2 inch from the edge of the base metal.

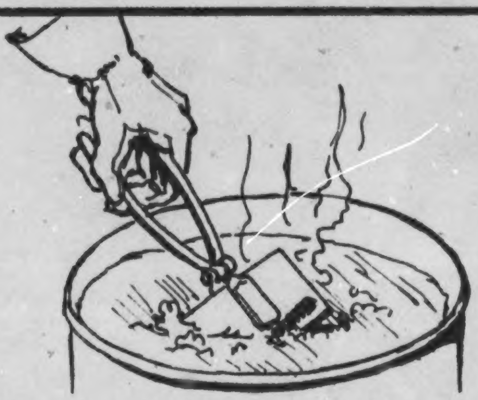


11. Shut off the torch.

CAUTION!

Never touch or pick up a hot metal piece with your hands.





Always make sure the welded metal has cooled before you handle it.

Always use the pliers.

12. Clean your work area and return tools to their right places.

SEE YOUR INSTRUCTOR

Unit 4
Running a Bead without Filler Rod

Tools and Materials Identification Exercise.

Match each tool with its correct name.

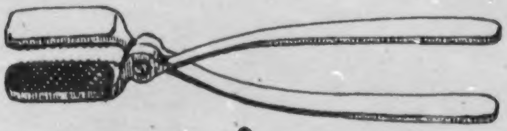
_____ A. Wire Brush

_____ B. Pliers

_____ C. Metal Vise

_____ D. Metal File

_____ E. Number 3 Torch Tip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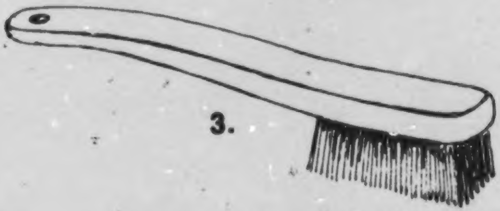
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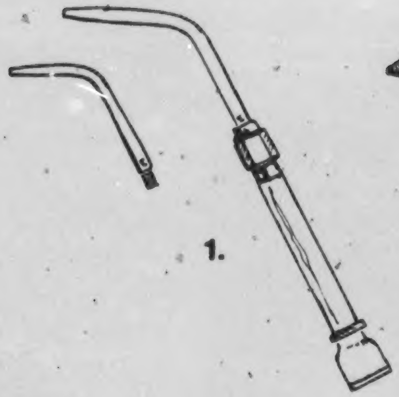
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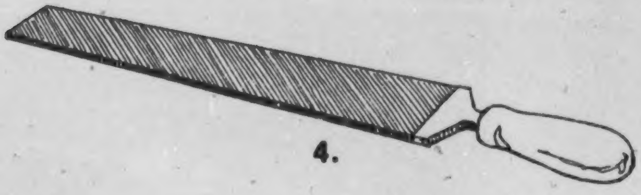
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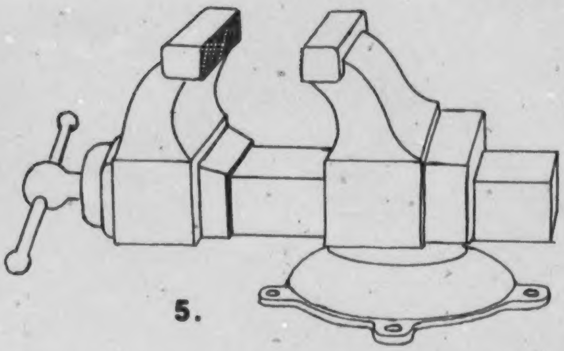

5.

Unit 4
Running a Bead without Filler Rod

Practical Exercise Performance Checklist

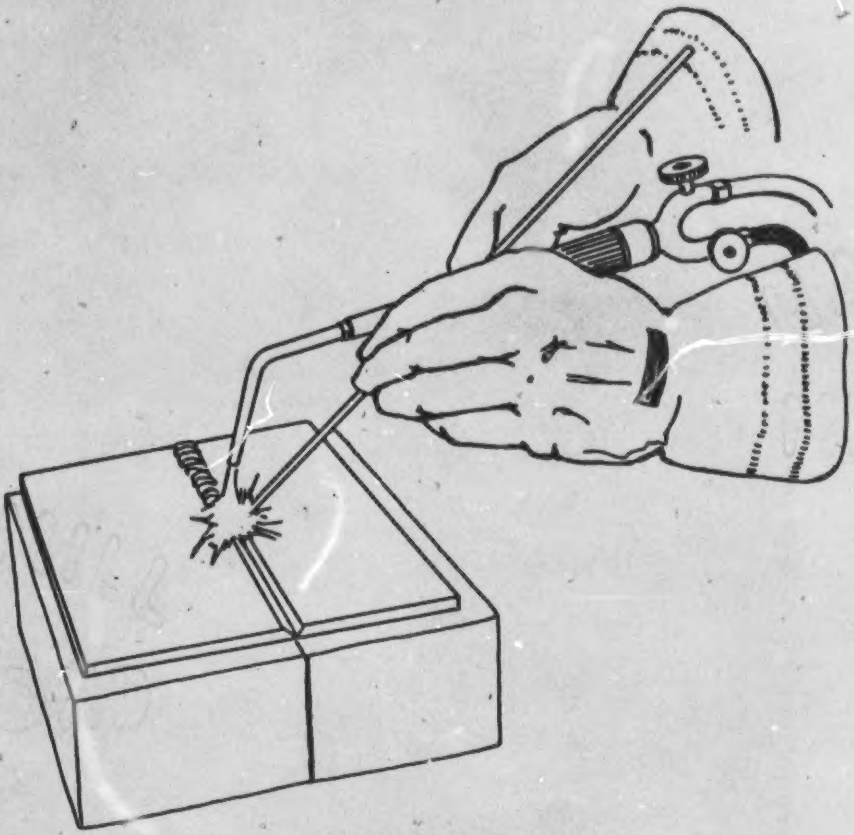
Student ______________________ successfully performed the following tasks:

Tasks	Yes	No	Comments
1. Identified:			
a. Wire brush			
b. Pliers			
c. Metal vise			
d. Metal file			
e. Number 3 torch tip			
2. Wore proper safety equipment			
3. Properly filed and smoothed base metal			
4. Drew lines on base metal to guide welding activity			
5. Properly positioned base metal for welding			
6. Selected and properly attached the torch tip			
7. Lighted and adjusted the welding torch to neutral flame			
8. Heated the metal until a puddle formed			
9. Moved the torch at correct speed in small circles and formed puddle along the first soapstone line			
10. Properly ran beads on the second line			
11. Properly handled the hot base metal after welding			
12. Cleaned work area and returned tools to their proper places			

Satisfactory Performance ☐
Repeat Exercise ☐
Should Move On ☐

______________________ ________
Instructor's Signature Date

Vocational Preparation Curriculum
WELDING



Unit 5

Running a Bead with Filler Rod

Developed by: Hogan Usoro

PRACTICAL ARTS
AND
VOCATIONAL-TECHNICAL
EDUCATION
IML
INSTRUCTIONAL MATERIALS LABORATORY
UNIVERSITY OF MISSOURI-COLUMBIA

Unit 5
Running a Bead with Filler Rod

Running a Bead with Filler Rod

After you study this unit, you should be able to:

1. Identify tools and materials used in running a bead with filler rod.
2. Clean a piece of metal for welding.
3. Run welding beads with a filler rod.

Show What You Can Do.

Check the statement that fits you best.

1. ☐ **I can do all the tasks above and want my instructor to give me the Practical Exercise.**

SEE YOUR INSTRUCTOR

2. ☐ **I want to study the information in this unit before I do the Practical Exercise.**

TURN THE PAGE AND BEGIN

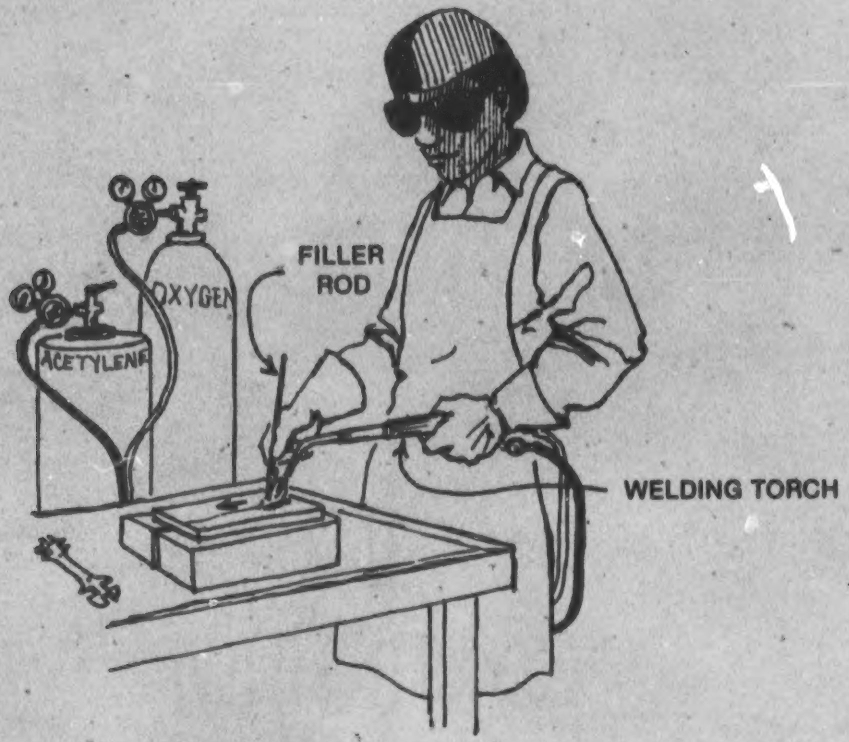
Unit 5
Running a Bead with Filler Rod

Introduction

You have already run a bead without filler rod. This unit will show you how to run a bead with filler rod. The ability to run a bead with filler rod is an important skill.

In this unit you will go through the steps for running a bead with filler rod.

Now, you are ready to begin.


OXYGEN
ACETYLENE
FILLER ROD
WELDING TORCH

TURN TO NEXT PAGE

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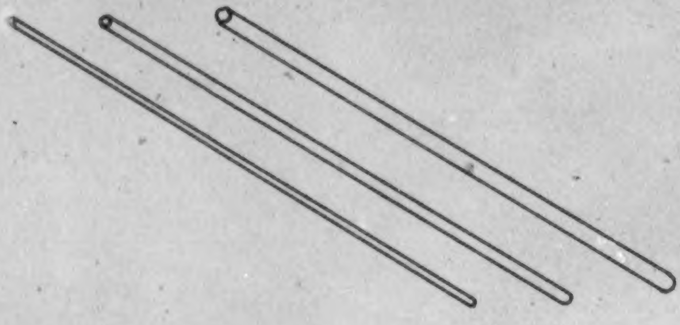
Unit 5

Running a Bead with Filler Rod

A. Tools, Materials and Equipment for Running a Bead with Filler Rod.

The only new material you need for this unit is filler rod. You will use most of the same tools and materials that you used in the last lesson. These are shown on the next page.

1. **FILLER ROD:** Metal to be melted with torch heat to form a bead or make a joint.



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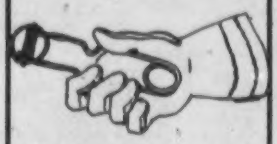
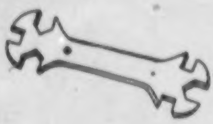
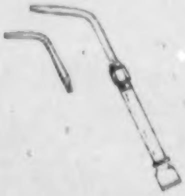
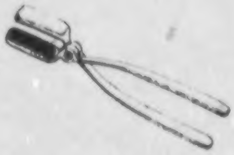
B. Steps for Running a Bead with Filler Rod

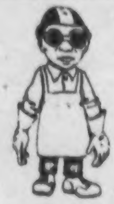
1. Find and Check Off the following:

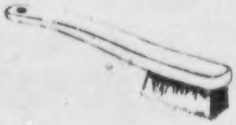

☐ Sparklighter

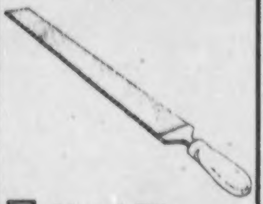

☐ Torch Tip Wrench

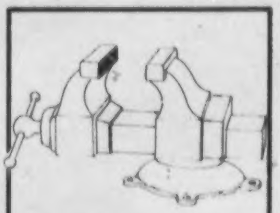

☐ Welding Tip

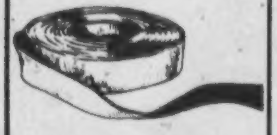

☐ Pliers

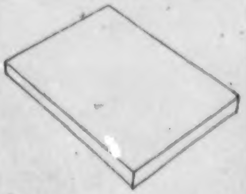

☐ Safety Equip.

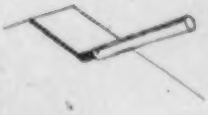

☐ Wire Brush

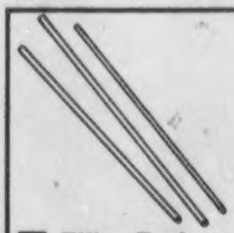

☐ Metal File


☐ Vise

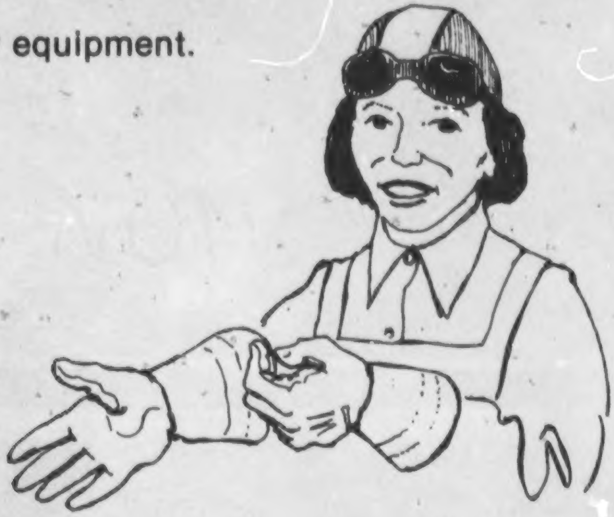

☐ Emery Cloth


☐ Base Metal

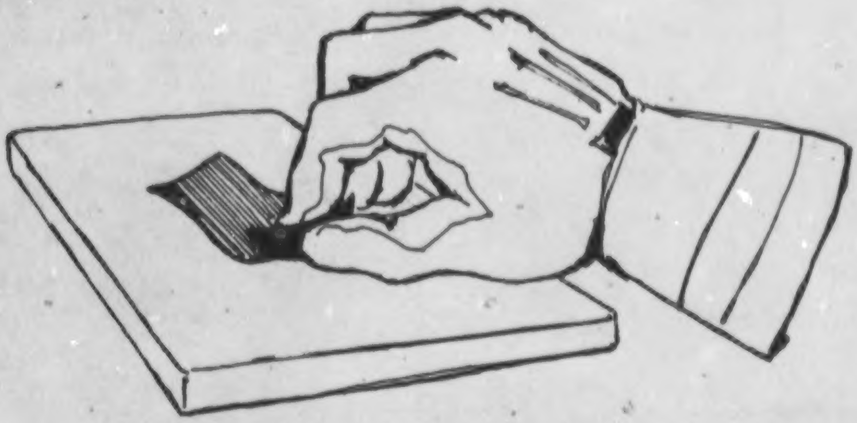

☐ Soapstone


☐ Filler Rod

2. Wear proper safety equipment.



3. Obtain a 1/8-inch base metal, 4 inches wide and 6 inches long. Secure it in the vise and file away the rough edges.

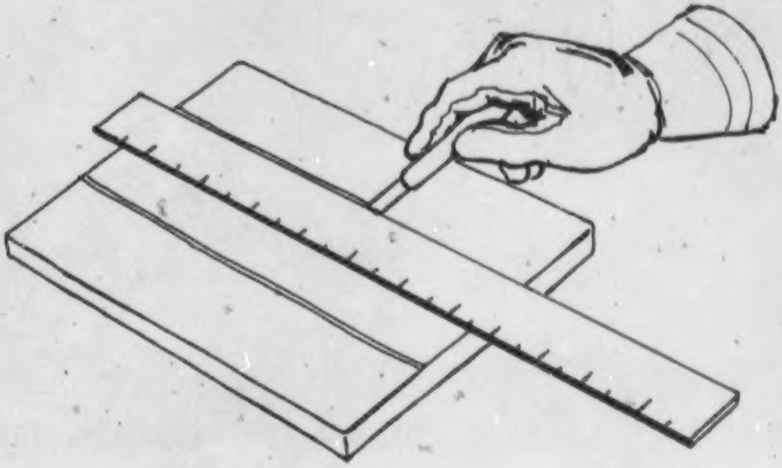


Smooth the surface with the emery cloth.

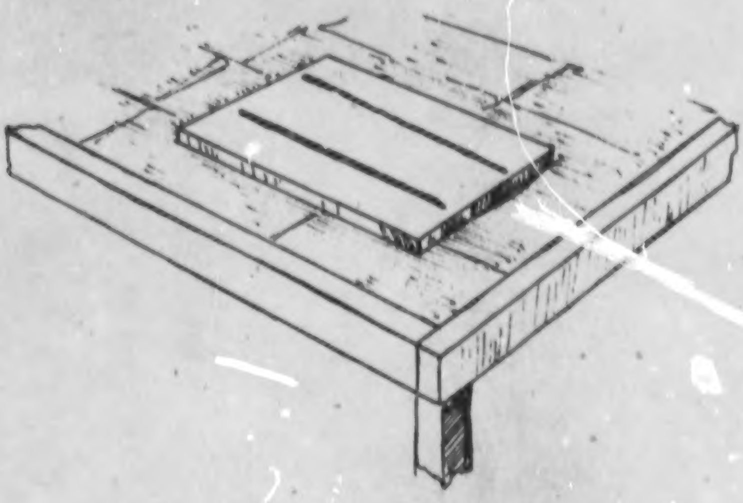
NOTE!

Always clean the metal surface or the weld will not stick properly.

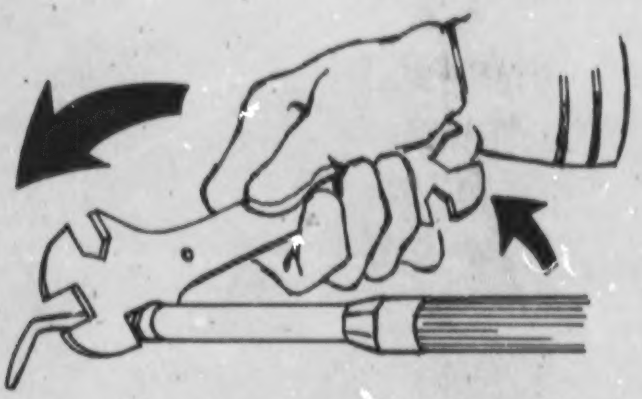
4. Draw two straight lines with the soapstone on the metal surface. Use a straight edge ruler if you have trouble.



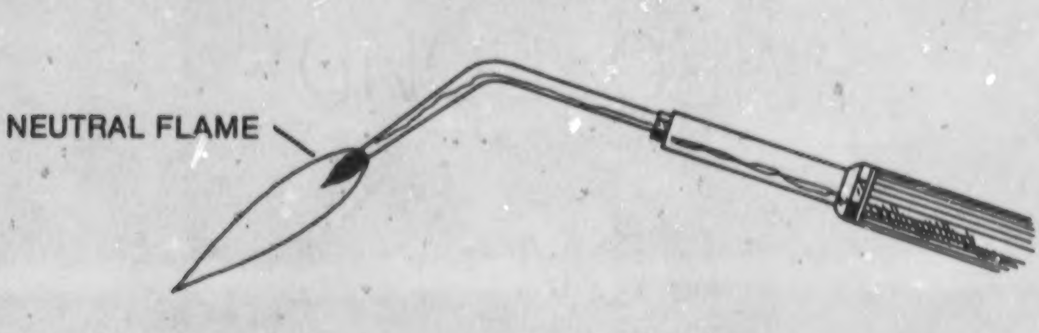
5. Place the base metal in a welding position.



6. Attach torch tip Number 3. Tighten the torch tip with the torch tip wrench.



7. Light and adjust the welding torch to a neutral flame.



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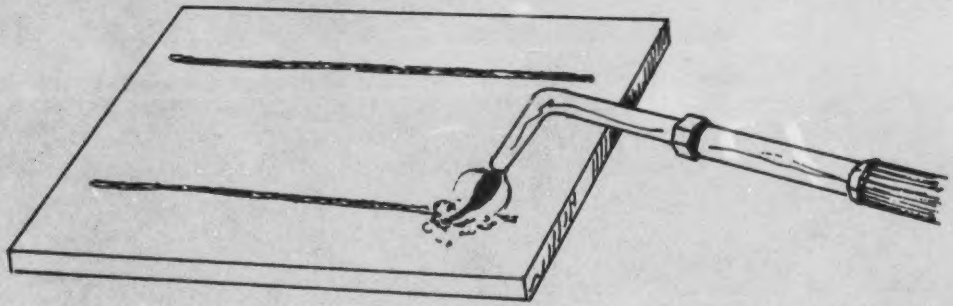
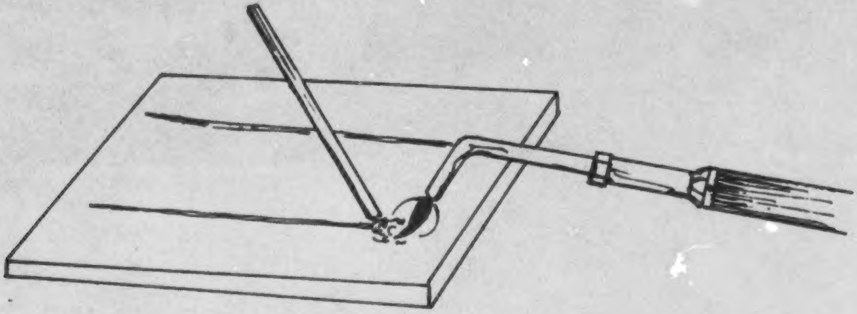
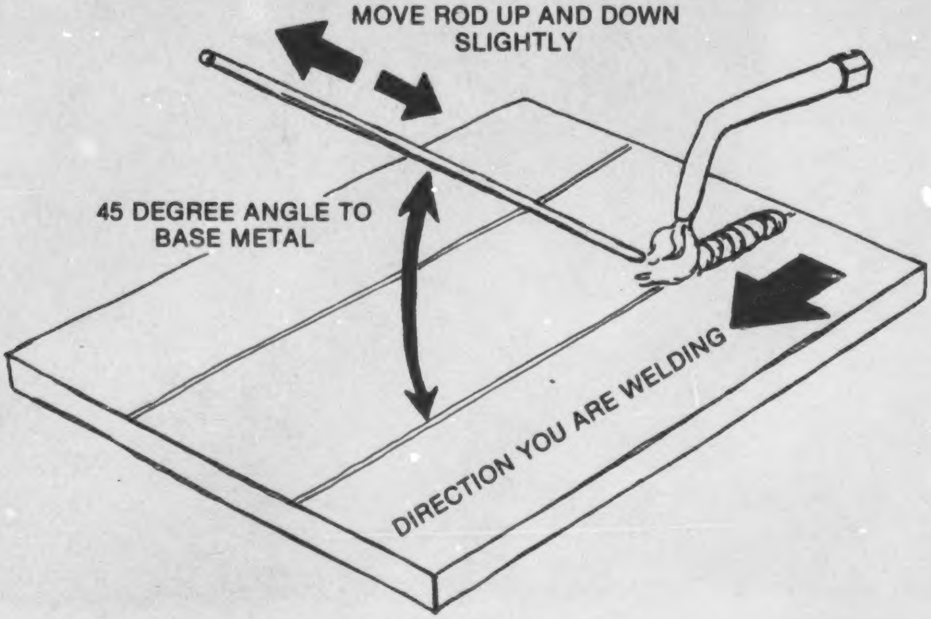
8. Heat the metal until a puddle forms.



9. When the puddle forms, add the filler rod to it in front of the torch.

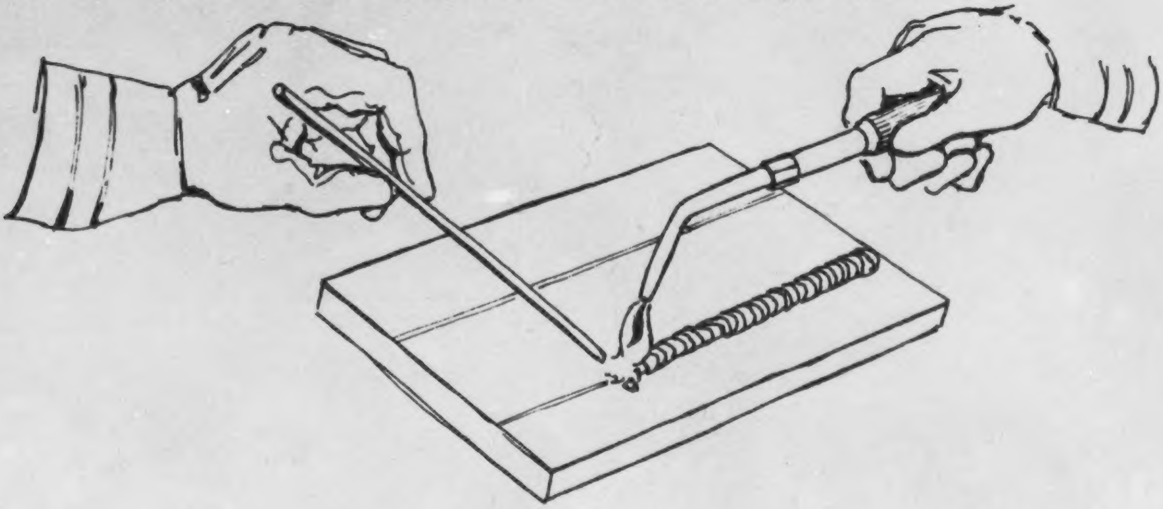


10. As you add the filler rod, move the puddle forward with the torch.

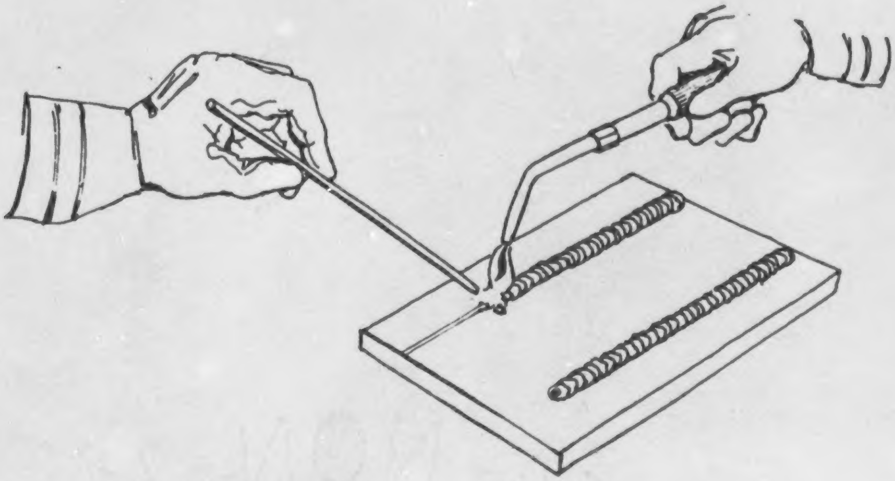

MOVE ROD UP AND DOWN SLIGHTLY
45 DEGREE ANGLE TO BASE METAL
DIRECTION YOU ARE WELDING

Melt and withdraw the filler rod as you move the puddle forward.

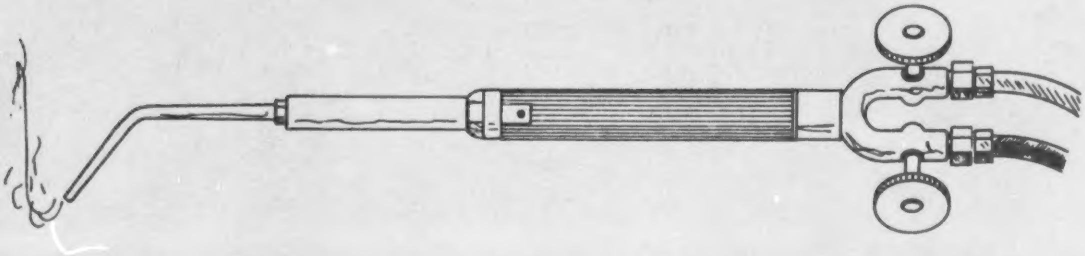
11. Continue to run the bead along the line on the base metal. Keep the bead shapes even and in a straight line.



12. Run beads along the second soapstone line.



13. Shut off the welding torch.

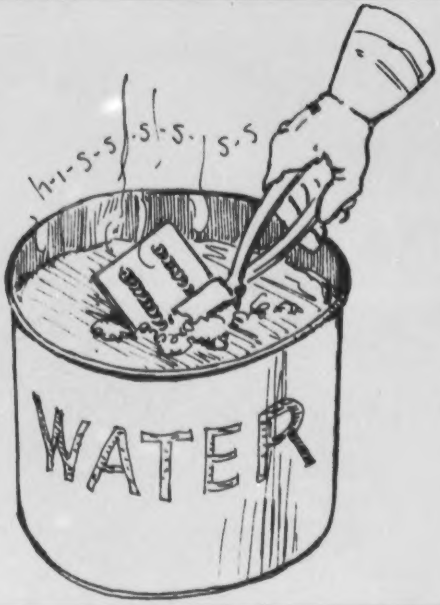


14. Allow the metal to cool or cool it in a bucket of water.

CAUTION!

ALWAYS use pliers to move the hot base metal.

ALWAYS allow the base metal to cool before handling.



Clean up your work area and return tools to their right places.

SEE YOUR INSTRUCTOR

Unit 5
Running a Bead with Filler Rod

Practical Exercise Performance Checklist

The Student ______________________ successfully performed the following tasks:

Tasks	Yes	No	Comments
1. Wore proper safety equipment			
2. Properly cleaned the base metal			
3. Drew lines on the base metal with soapstone or chalk			
4. Properly positioned the base metal for welding			
5. Attached the correct torch tip			
6. Lighted and adjusted the torch to obtain a neutral flame			
7. Preheated the base metal until a puddle formed on it			
8. Properly added a filler rod to the puddle			
9. Added the filler rod with the foward movement of the puddle			
10. Ran the bead along the soapstone lines			
11. Formed evenly-shaped beads			
12. Moved or handled the hot metal safely			
13. Shut off the torch correctly			
14. Cleaned up the work area and returned tools to their places			

Satisfactory Performance ☐

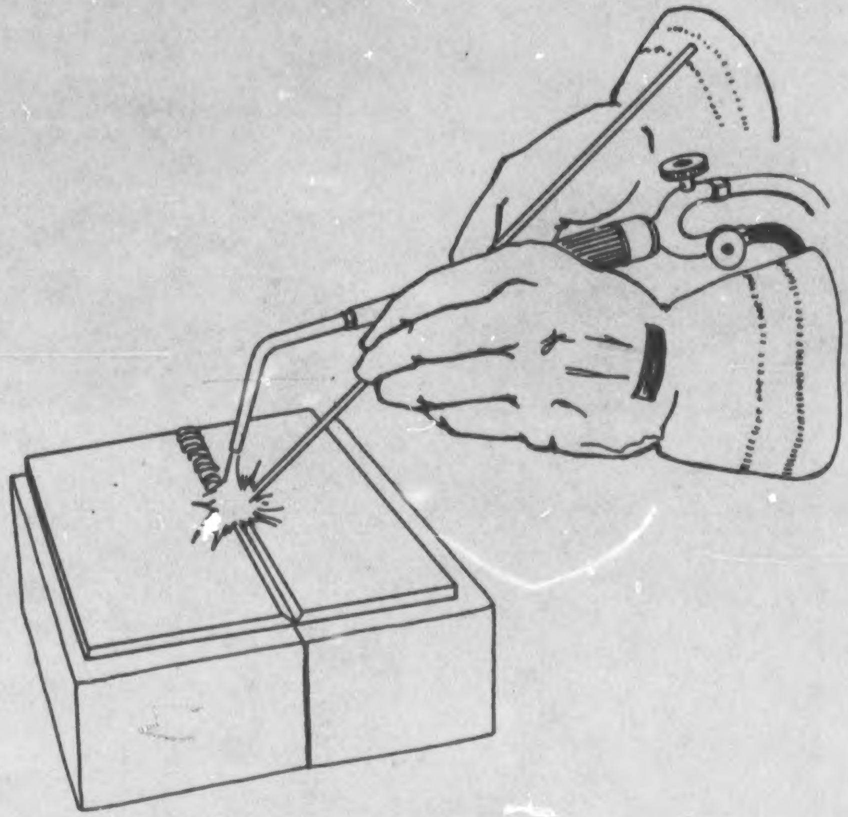
Should Move On ☐

Repeat Exercise ☐

______________________ Instructor's Signature

__________ Date

Vocational Preparation Curriculum
WELDING



Unit 6

Brazing a Butt Joint

Developed by: Hogan Usoro

PRACTICAL ARTS
AND
VOCATIONAL-TECHNICAL
EDUCATION
iml
INSTRUCTIONAL MATERIALS LABORATORY
UNIVERSITY OF MISSOURI-COLUMBIA

Unit 6
Brazing a Butt Joint

Brazing a Butt Joint.

After you study this lesson, you should be able to:

1. Identify tools and materials used in brazing a butt joint.
2. Light and adjust a torch to an oxidizing flame.
3. Braze a butt joint.

Show What You Can Do.

Check the statement that fits you best.

1. ☐ **I can do all the tasks above and want my instructor to give me the Practical Exercise.**

SEE YOUR INSTRUCTOR

2. ☐ **I want to study the information in this unit before I do the Practical Exercise.**

TURN THE PAGE AND BEGIN

Unit 6
Brazing a Butt Joint

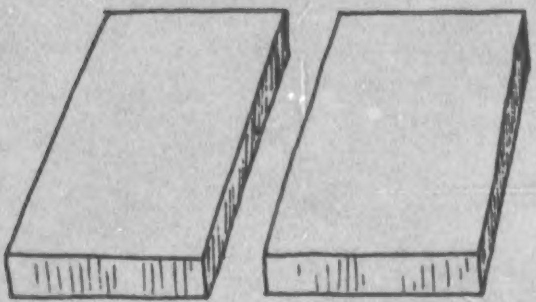
Introduction

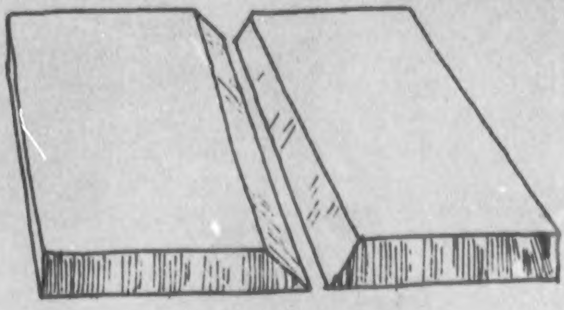
You have learned how to use the filler rod and torch flame for welding. This lesson will show you how to join metals using a method called brazing. Brazing is the surface joining of metals with a brazing rod and torch flame. Brazing can be used:

To join two like metals.

To join two unlike metals.

In this lesson, you will learn how to make a butt joint using the brazing method. What is a butt joint? A butt is a joint between two metal pieces lying on the same surface.


butt joint


beveled butt joint

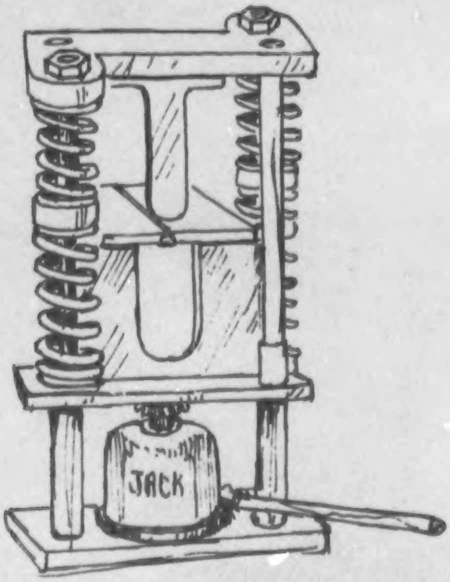
It is hoped you will like this lesson.

TURN TO NEXT PAGE

Unit 6
Brazing a Butt Joint

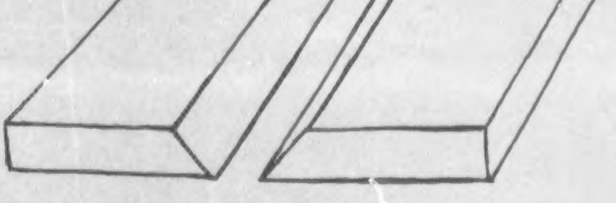
A. Tools, Materials and Equipment for Brazing a Butt Joint.

1. **HYDRAULIC JIG:** Used to test the strength of a welded or brazed joint.

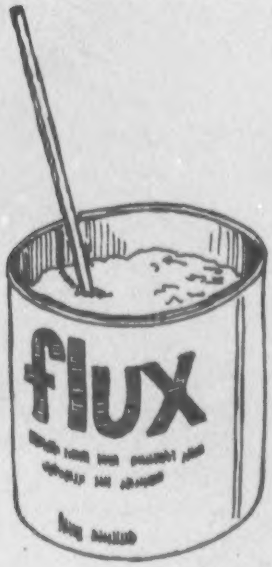


2. **BRAZING ROD:** A non-ferrous metal melted indirectly with the heat from flame to join metals together. A non-ferrous metal is a metal that contains no iron.

3. **BASE METALS (with beveled edges):** Metal pieces to join together by brazing.



4. **FLUX:** A powdery or pasty material used to help the brazing rod flow smoothly as it melts.
Flux is also used to remove dirt during brazing.



You have already learned about other tools and materials required for this lesson. These are shown on the next page.

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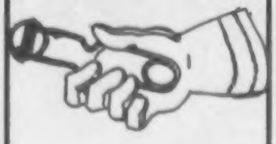
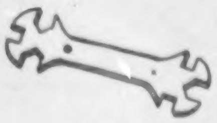
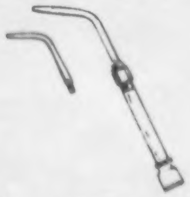
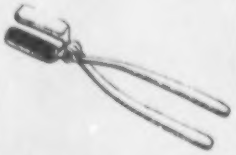
B. Steps for Brazing a Butt Joint.

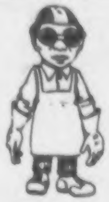
1. Find and Check Off the following:

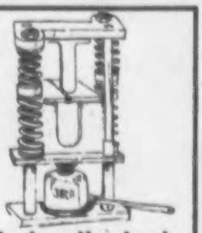

☐ **Sparklighter**

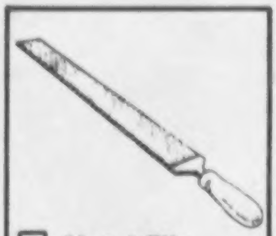

☐ **Torch Tip Wrench**

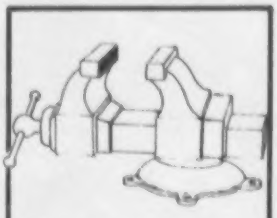

☐ **Welding Tip**

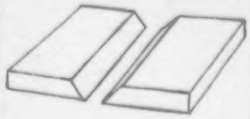

☐ **Pliers**

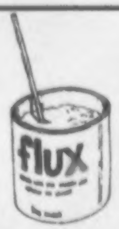

☐ **Safety Equip.**


☐ **Hydraulic Jack**

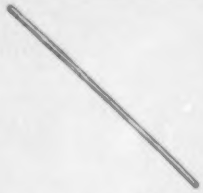

☐ **Metal File**


☐ **Vise**

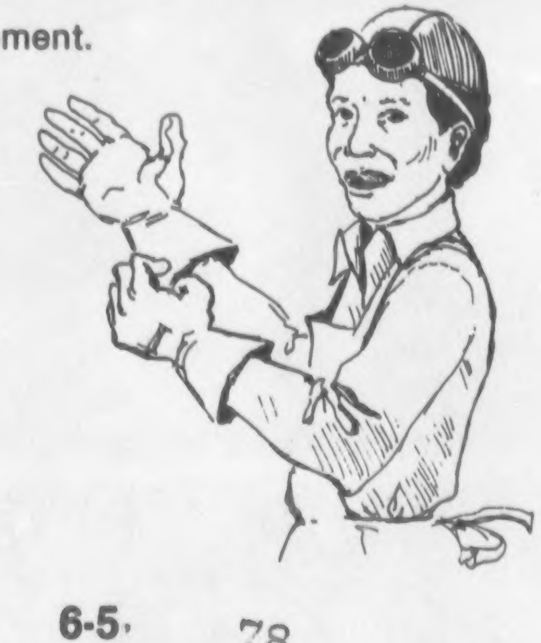

☐ **Base Metal**



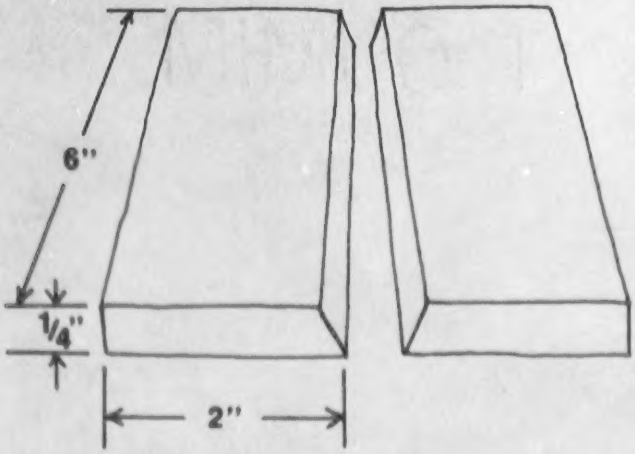
☐ **Flux**


☐ **Brazing Rod**

2. Wear proper safety equipment.



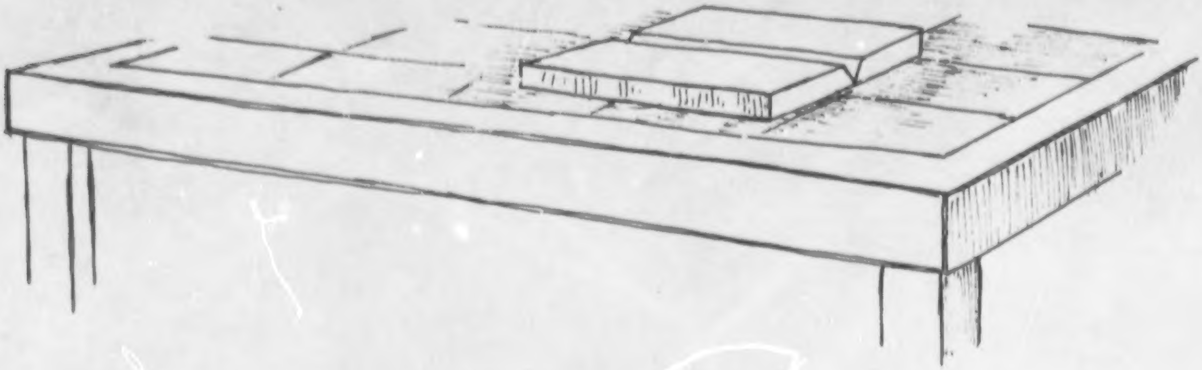
3. Obtain two pieces of mild steel each 1/4 x 2 x 6 inches in size. Secure each in vise and clean the beveled edge with the file.



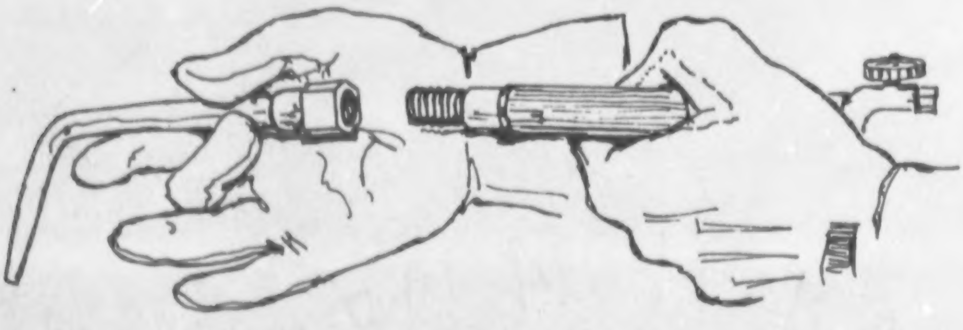
NOTE!

Make sure the metal joint is clean. Molten metal from the brazing rod will not flow smoothly and evenly if the metal surface is dirty.

4. Place the metal pieces in proper position on the welding table.



5. Select and attach a Number 5 torch tip to the welding torch.



Tighten the torch tip lightly with the torch tip wrench.

Carefully review the safety cautions you have already learned.

CAUTION!

ALWAYS stand to one side of the cylinder while opening the valves.

ALWAYS open the cylinder valves slowly.

NEVER exceed 15 pounds per square inch on the acetylene working pressure gauge.

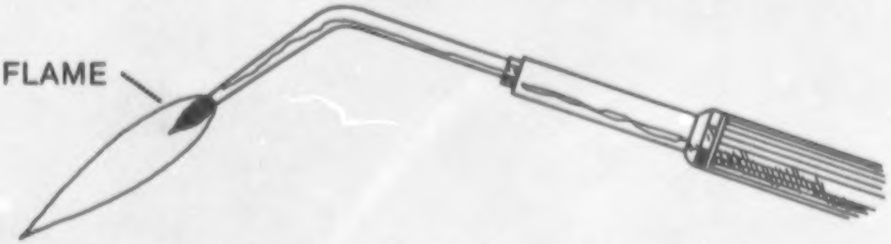
ALWAYS protect your eyes with goggles.

NEVER light a torch with a match stick.

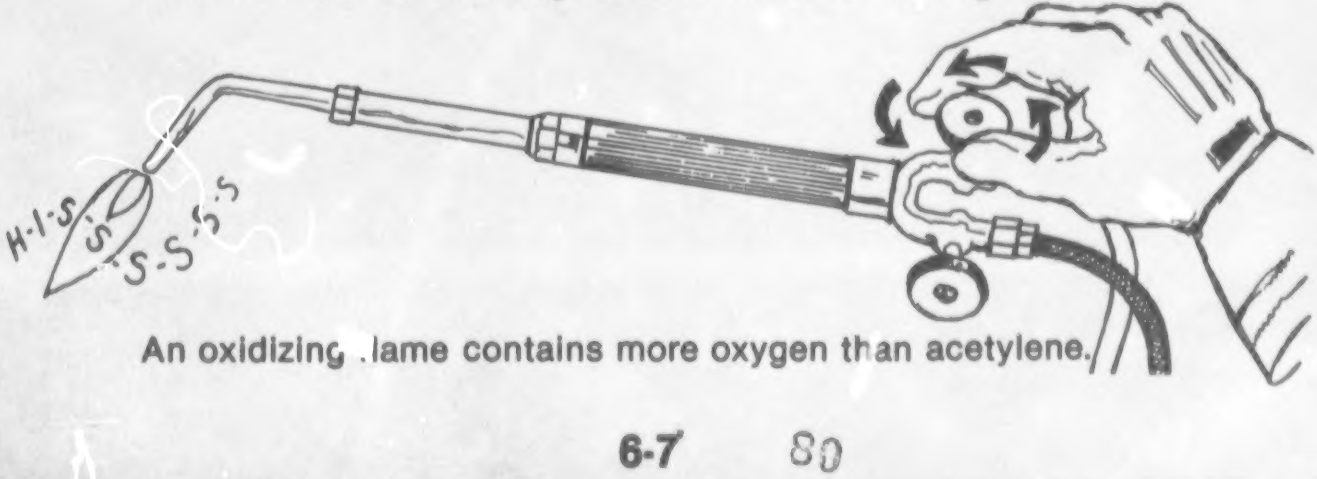
ALWAYS point the torch downward or against the welding table top.

NEVER point the torch toward yourself or others.

6. Light and adjust the welding torch to a neutral flame.

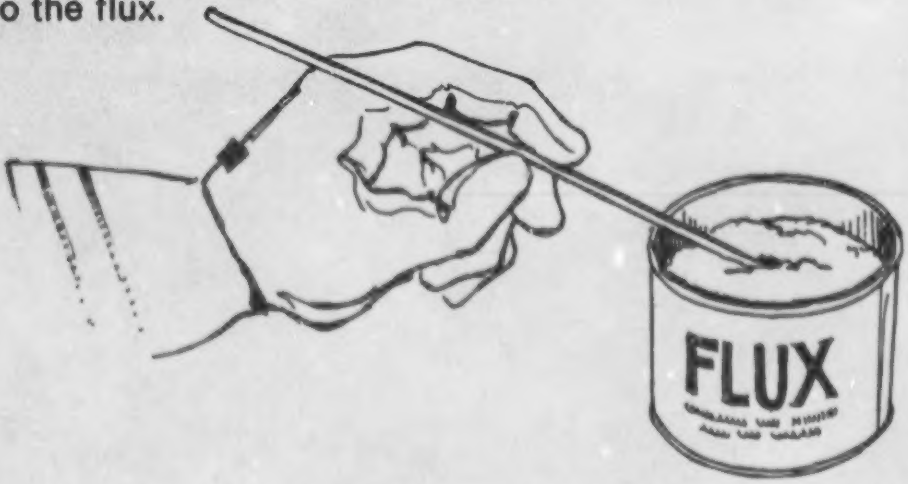


7. To obtain an oxidized flame continue to turn the **oxygen needle valve** to the left until you obtain a flame with a short white pointed inner cone.
This flame is an oxidizing flame. It makes a hissing noise.

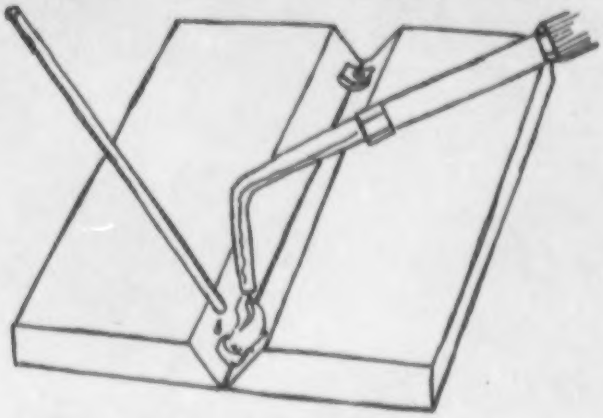


An oxidizing flame contains more oxygen than acetylene.

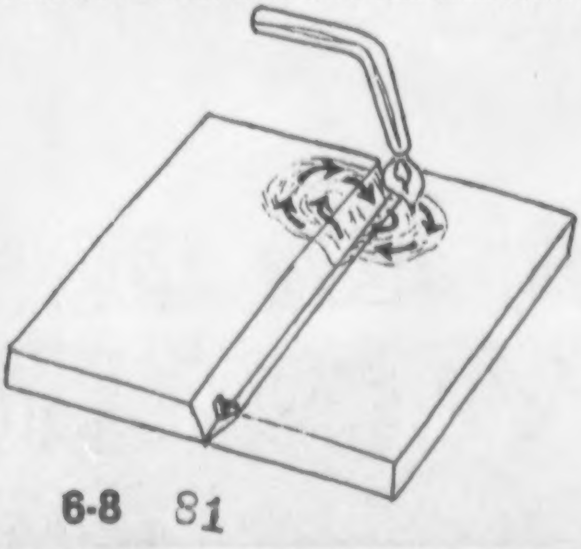
8. Obtain a 1/8-inch diameter brazing rod. Heat one end and dip it into the flux.



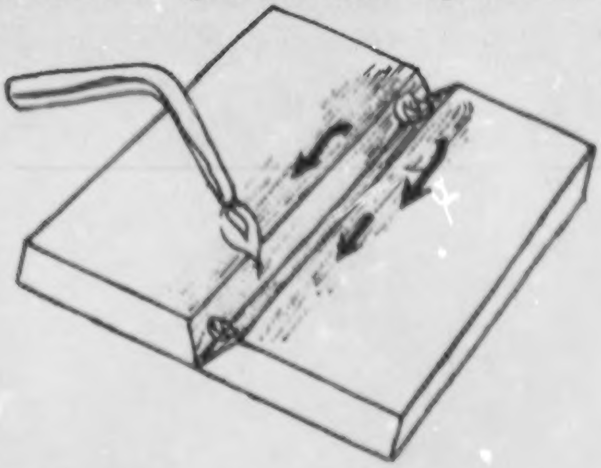
9. Heat the base metals and tack weld at each end.
Tack welding will hold the base metals in position for brazing.



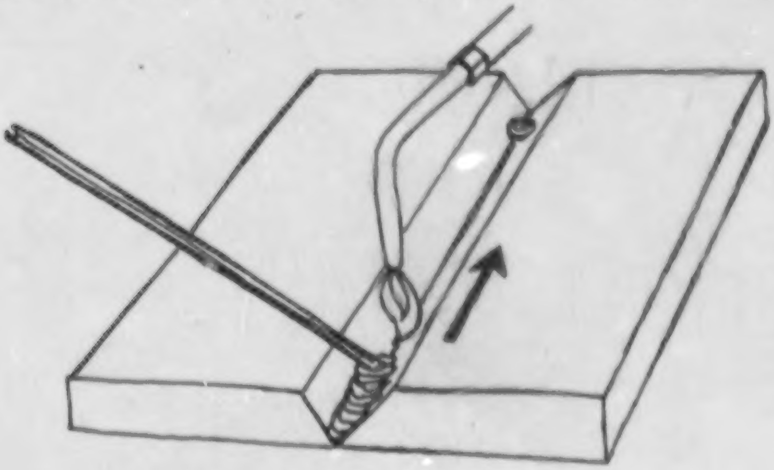
10. Heat the base metal at one end until it is dull red.
As you heat the metal, move the torch in a circular manner.



11. When the metal is red hot, move the torch to the bottom of the v-shaped joint. Heat along the entire length of the joint.



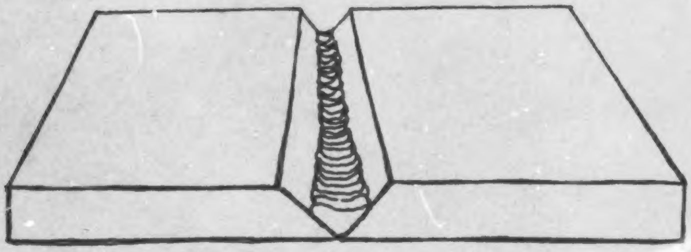
12. Melt some flux from the rod into the joint. Apply the brazing rod to the heated joint and proceed to braze along the joint.



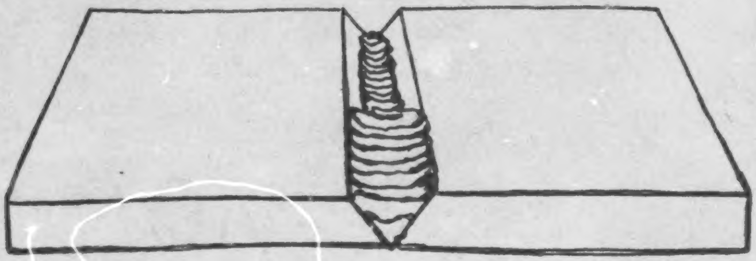
NOTE!

DO NOT allow the flame to strike the brazing rod directly. This will make a weakly brazed joint.

13. Lay one run of beads at a time. Start at the bottom of the v-shaped joint.



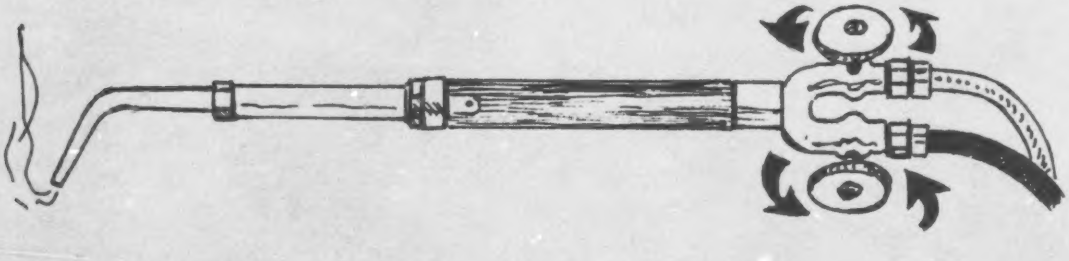
14. Continue running beads until the v-shaped joint is filled.



NOTE!

DO NOT fill the v-shaped joint with one bead run or you will make a poorly brazed joint.

15. Shut off the welding torch.



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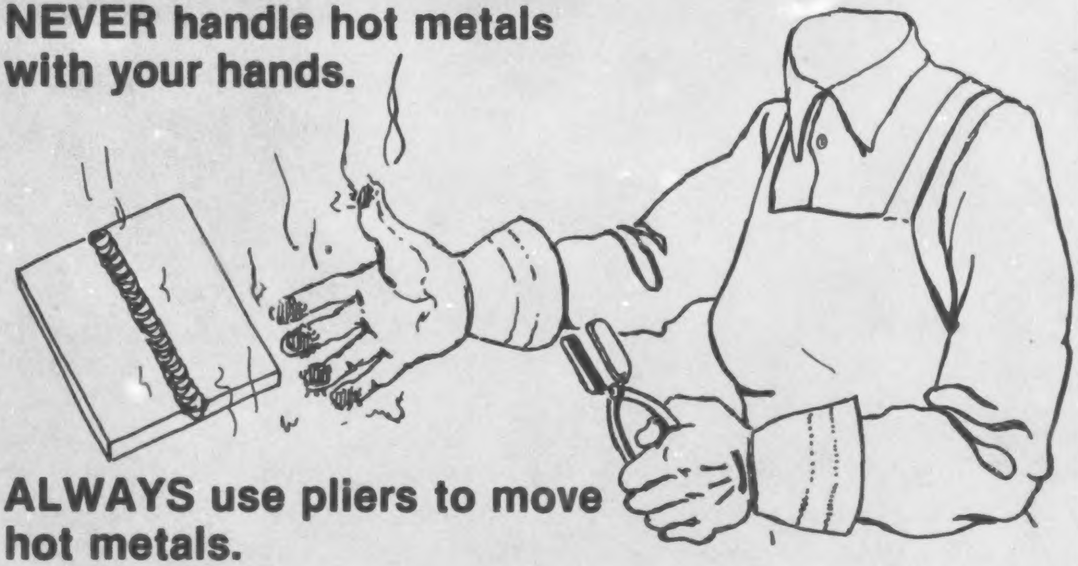
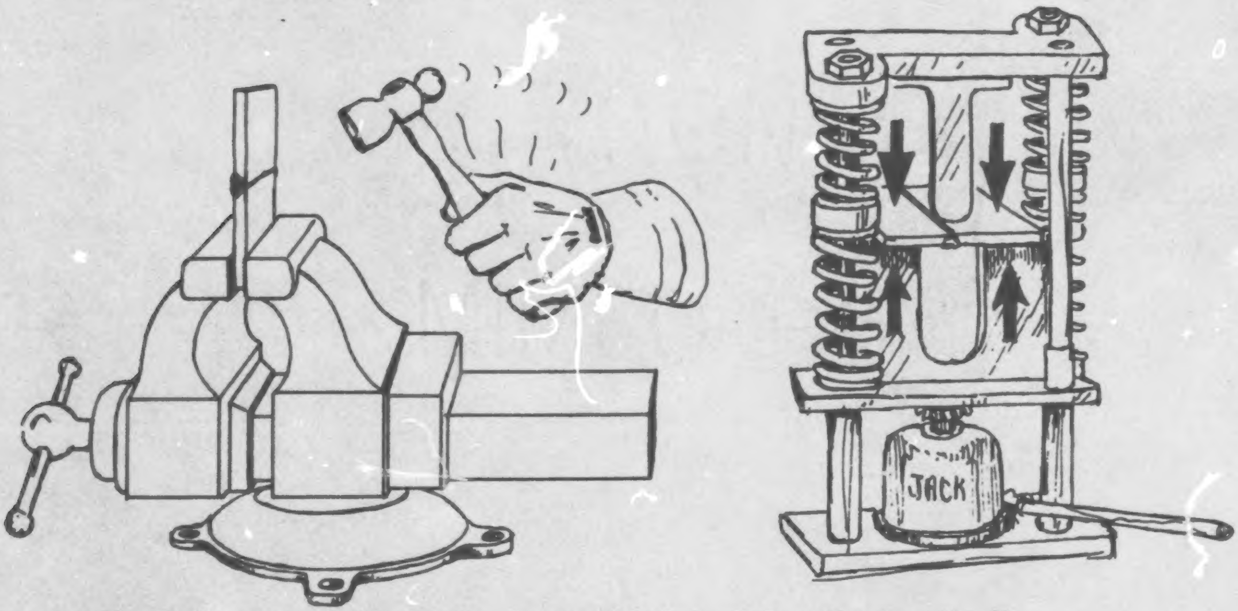
CAUTION!

NEVER handle hot metals with your hands.



ALWAYS use pliers to move hot metals.

16. Allow the brazed joint to cool.



Test the strength of the brazed joint with a hydraulic jig or hammer and vise.

17. Clean up your work area and return tools to their proper places.

SEE YOUR INSTRUCTOR

Unit 6
Brazing a Butt Joint

Practical Exercise Performance Checklist

The student ____________________ successfully performed the following tasks:

Tasks	Yes	No	Coments
1. Identified:			
a. Brazing rod			
b. Flux			
c. Beveled edge base metal			
d. Hydraulic jig			
2. Wore proper safety equipment			
3. Properly cleaned the base metals			
4. Correctly positioned the base metals on the welding table			
5. Selected and attached the correct torch tip			
6. Checked the welding equipment before lighting the torch			
7. Correctly opened the oxygen cylinder valve			
8. Correctly opened the acetylene cylinder valve			
9. Correctly set the oxygen working pressure gauge			
10. Correctly set the acetylene working pressure gauge			
11. Protected the eyes with goggles while opening the acetylene needle valve			
12. Lighted and adjusted the torch to a neutral flame			

Tasks	Yes	No	Comments
13. Opened the oxygen needle valve more to obtain an oxidizing flame			
14. Heated and dipped the brazing rod into flux			
15. Preheated and tack welded each end of the butt joint			
16. Correctly heated the base metals to dull red			
17. Heated the entire length of the butt joint			
18. Melted some flux from the rod into the joint			
19. Applied the rod to heated joint and proceeded to braze			
20. Laid one layer of beads at a time until the joint was filled			
21. Correctly shut off the torch			
22. Allowed the brazed joint to cool before moving or testing it			
23. Correctly tested the strength of the brazed joint			
24. Cleaned up the work area and returned tools to their right places			

Satisfactory Performance ☐
Repeat Exercise ☐
Should Move On ☐

Instructor's Signature Date

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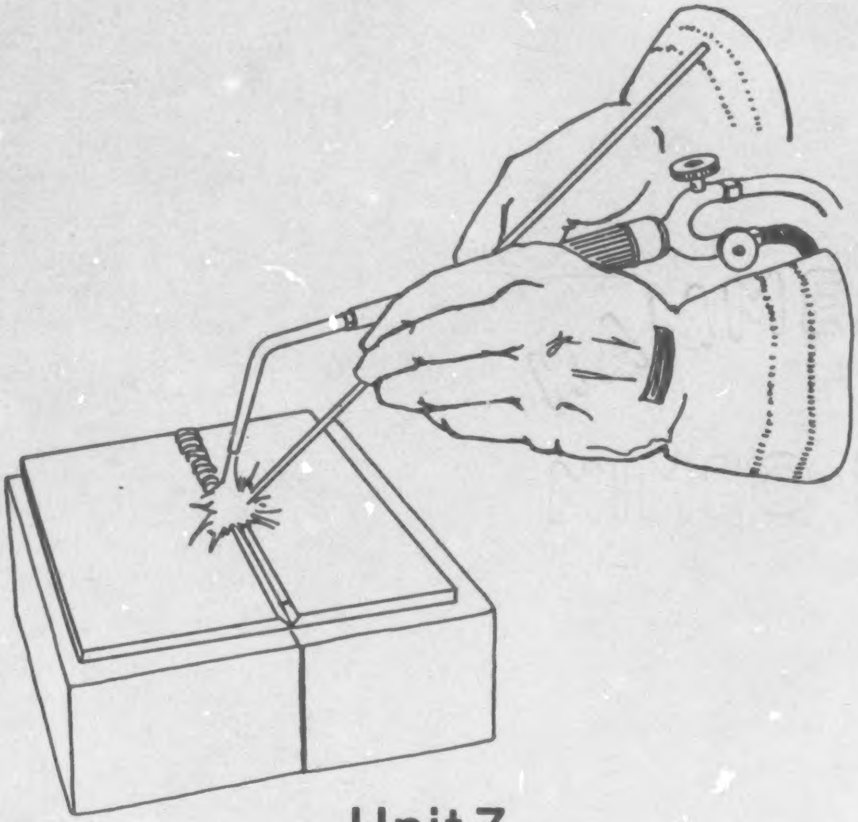
Vocational Preparation Curriculum
WELDING



Unit 7

Brazing a Lap Joint

Developed by: Hogan Usoro

PRACTICAL ARTS
AND
VOCATIONAL-TECHNICAL
EDUCATION

iml

INSTRUCTIONAL MATERIALS LABORATORY
UNIVERSITY OF MISSOURI-COLUMBIA

Unit 7
Brazing a Lap Joint

Brazing a Lap Joint

After you study this lesson, you should be able to:

1. Light and Adjust a welding torch to obtain an oxidizing flame.
2. Braze a lap joint.

Show What You Can Do.

Check the statement that fits you best.

1. ☐ **I can do all the tasks above and want my instructor to give me the Practical Exercise.**

SEE YOUR INSTRUCTOR

2. ☐ **I want to study the information in this unit before I do the Practical Exercise.**

TURN THE PAGE AND BEGIN

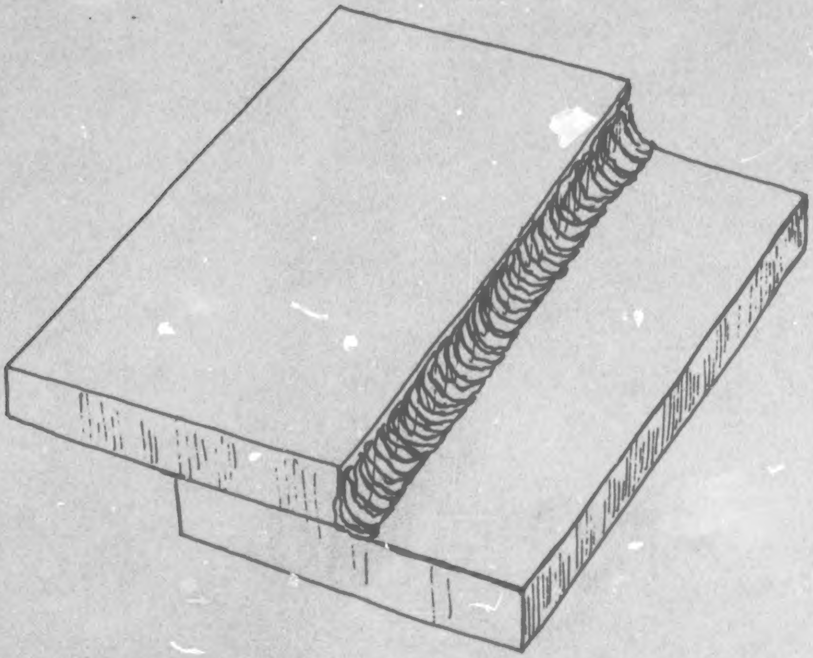
Unit 7
Brazing a Lap Joint

Introduction

You have already brazed a butt joint. In this lesson you will learn to braze a lap joint. A lap joint is formed by overlapping two pieces of metal.

This lesson requires the same tools and materials you used to braze a butt joint.

It is hoped this will be an interesting lesson for you. Let us begin.



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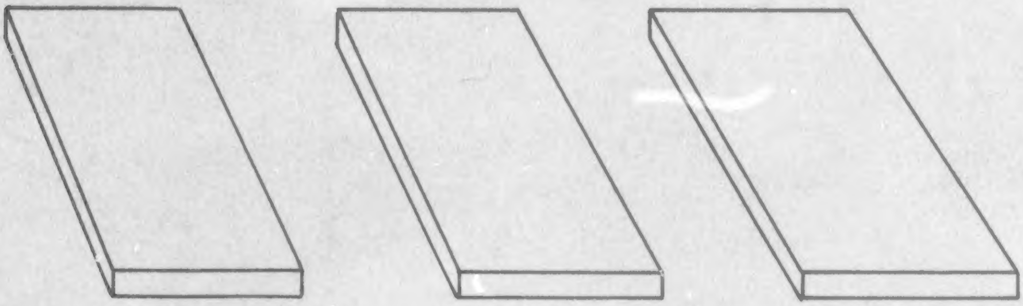
Unit 7
Brazing a Lap Joint

A. Tools, Materials and Equipment for Brazing a Lap Joint.

1. **BASE METALS:** Pieces of metal used to form the lap joint.



You have already learned about other tools and materials required for this lesson.

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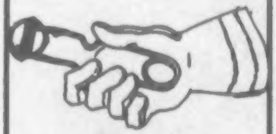
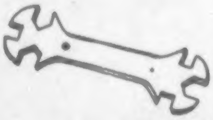
B. Steps for Brazing a Lap Joint

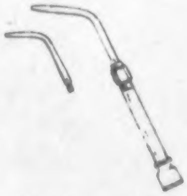
1. Find and Check Off the following:



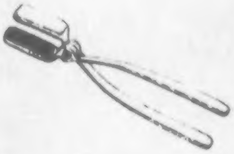
☐ **Sparklighter**



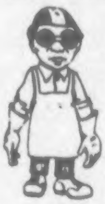
☐ **Torch Tip Wrench**



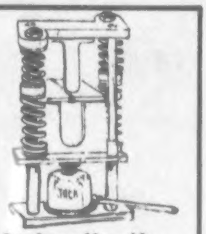
☐ **Welding Tip**



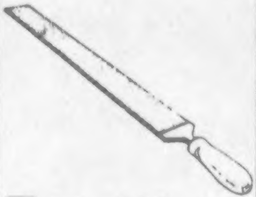
☐ **Pliers**



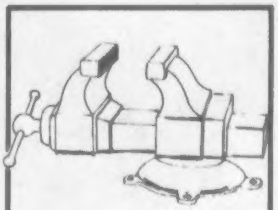
☐ **Safety Equip.**



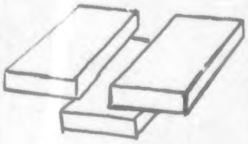
☐ **Hydraulic Jig**



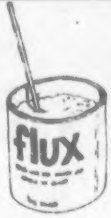
☐ **Metal File**



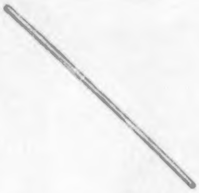
☐ **Vise**



☐ **Base Metal**

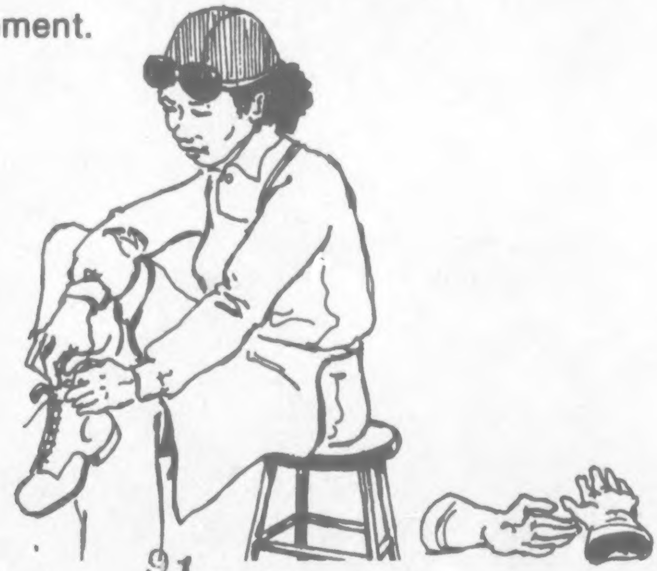


☐ **Flux**

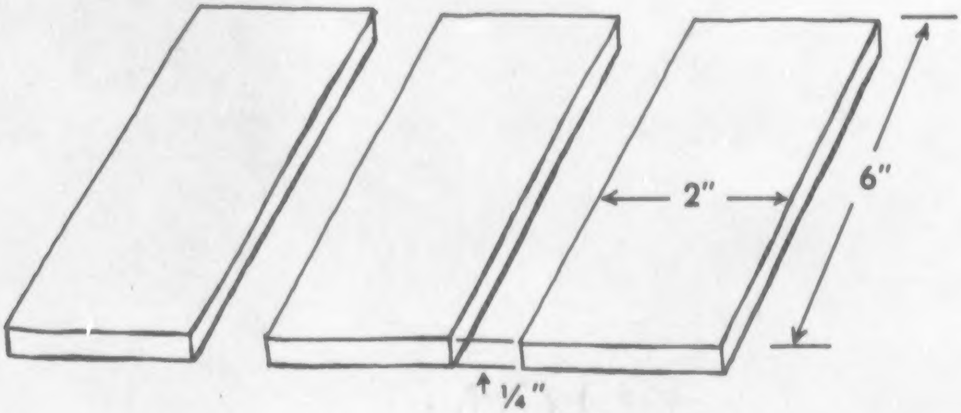


☐ **Brazing Rod**

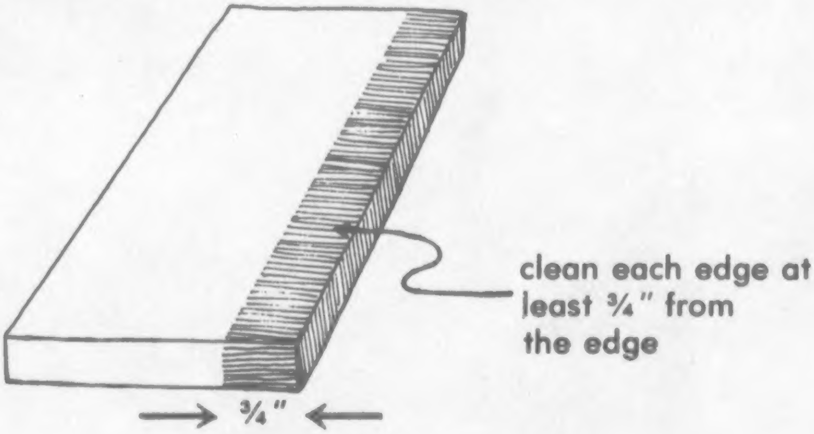
2. Wear proper safety equipment.



3. Obtain three pieces of base metal each 1/4" x 2" x 6". You will use the third piece for support only.



4. Secure each metal piece in a vise and clean it.


clean each edge at least ¾" from the edge
¾"

NOTE!

Make sure the metal pieces are clean, otherwise, the molten metal from the brazing rod will not flow evenly over it.

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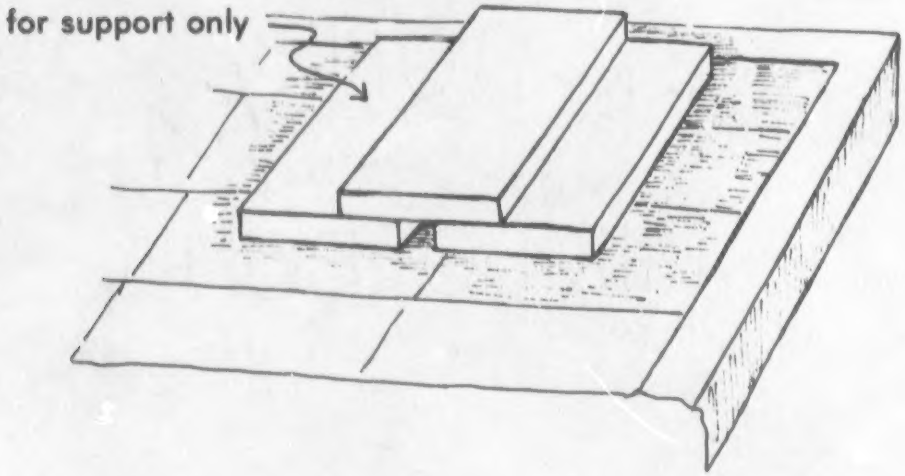
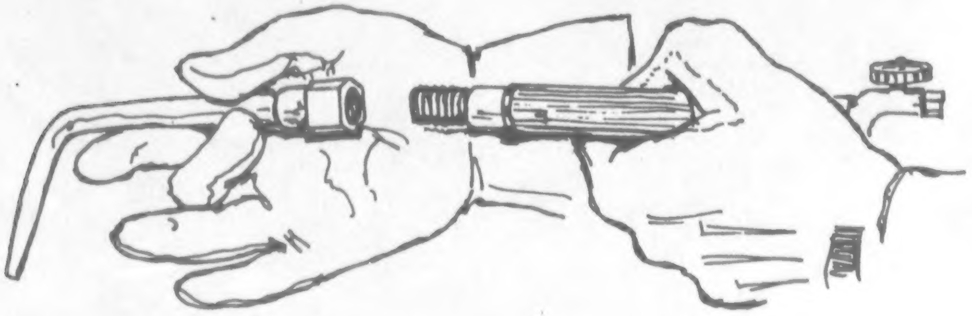
5. Position the metal pieces on the welding table. Allow one welding piece to overlap the other.

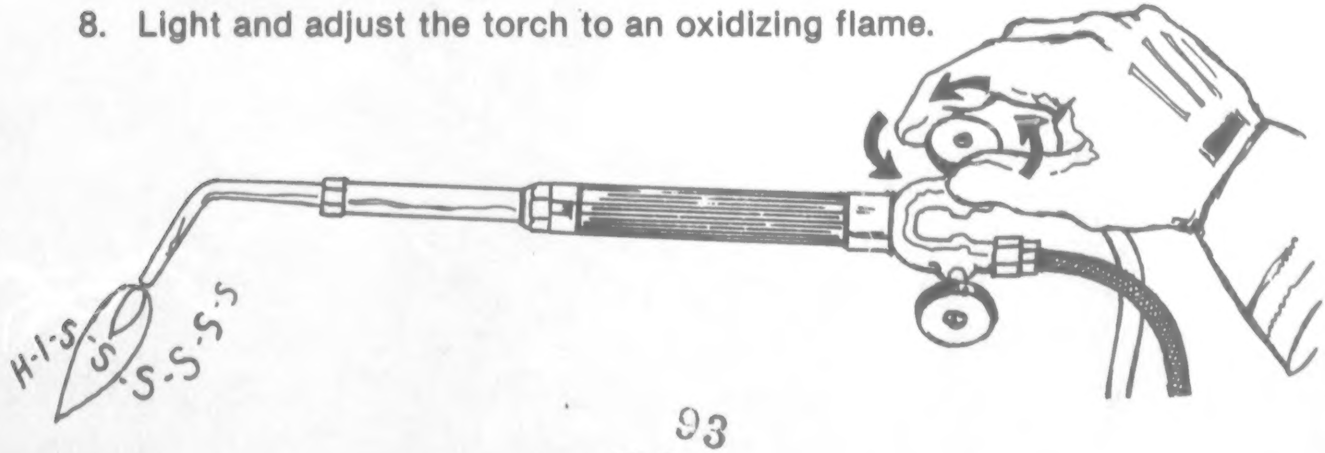


6. Select and attach a Number 5 torch tip. Tighten the tip slightly with the torch tip wrench.

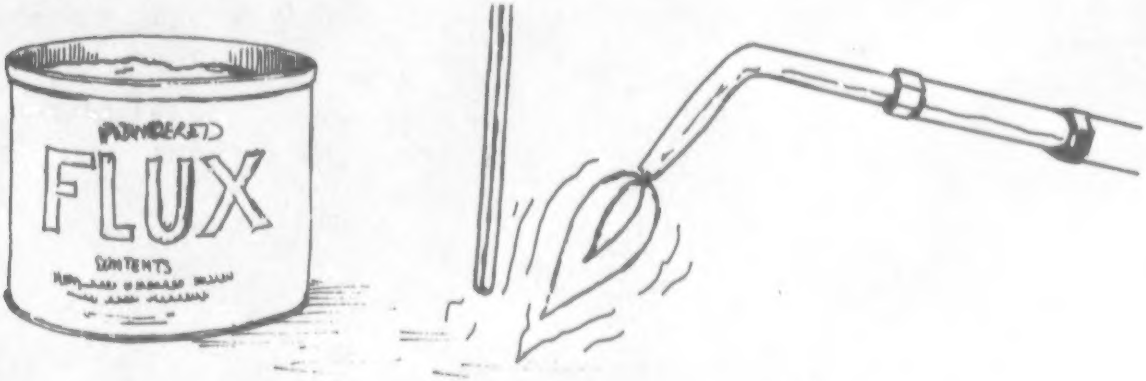


7. Set the oxygen and acetylene working gauges to correct pressures.

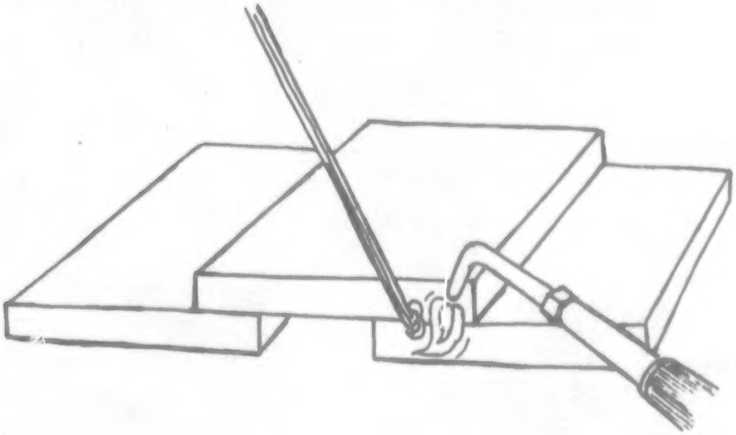
8. Light and adjust the torch to an oxidizing flame.



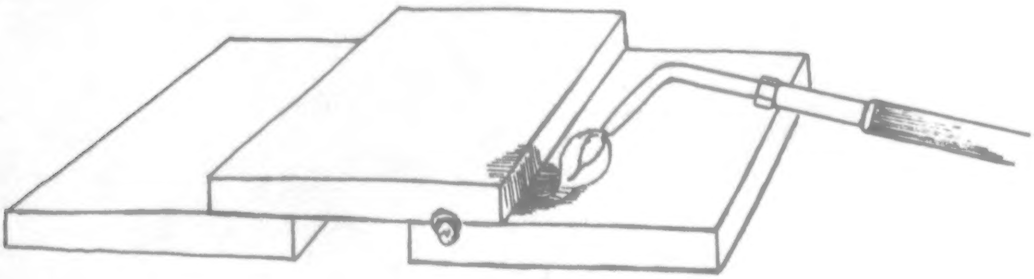
9. Obtain a 1/8" diameter brazing rod and flux. Heat one end of the rod and dip it into the flux.


POWDERED
FLUX
CONTENTS

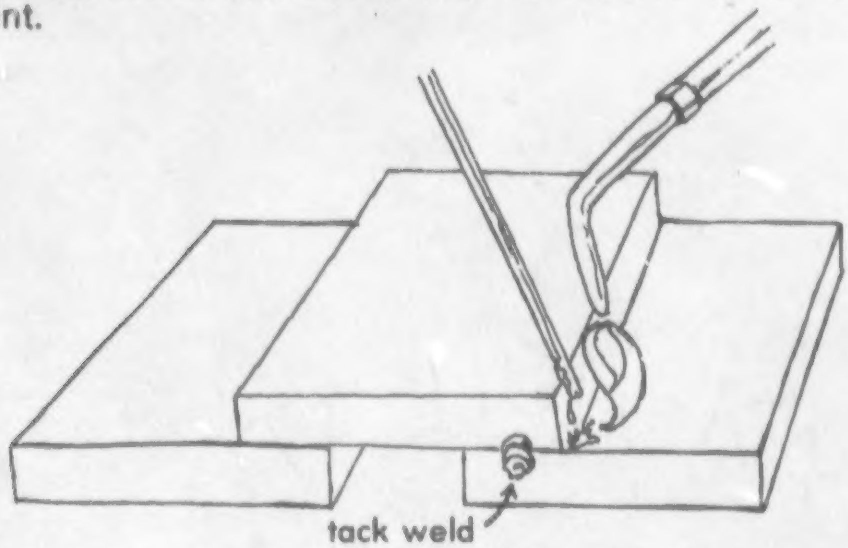
10. Heat and tack weld the lap joint at each end.



11. Heat a spot at the joint until the metal becomes dull red.



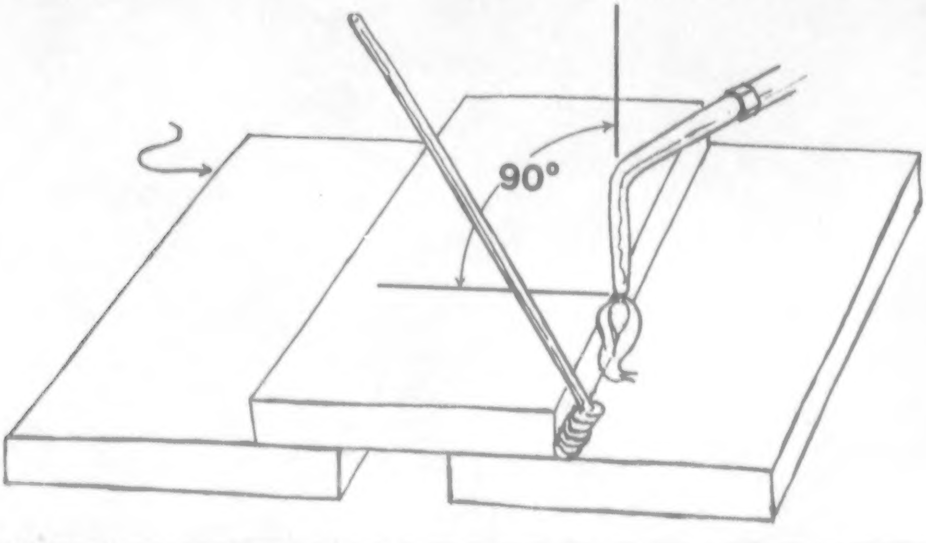
12. Melt some flux from the rod into the heated corner of the joint.



NOTE!

Make sure you heat both metal pieces evenly, otherwise, the bonding of the two pieces will not be uniform.

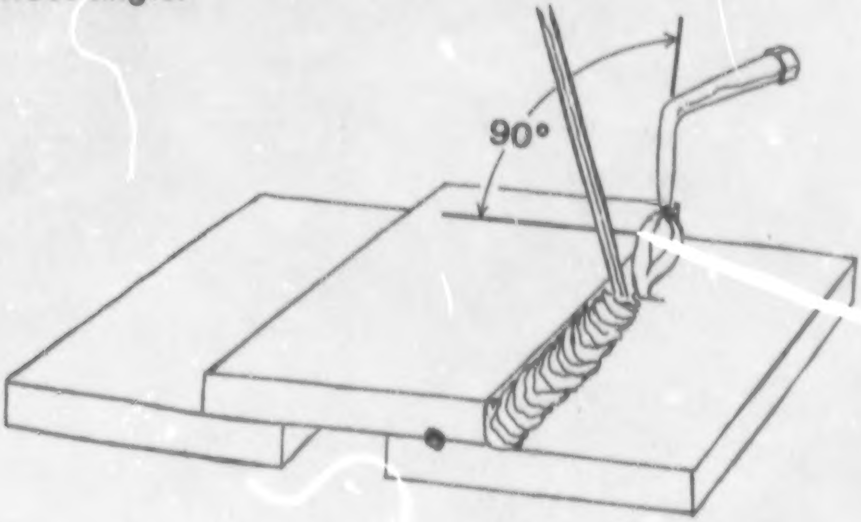
13. Melt the filler rod into the heated joint and begin brazing.



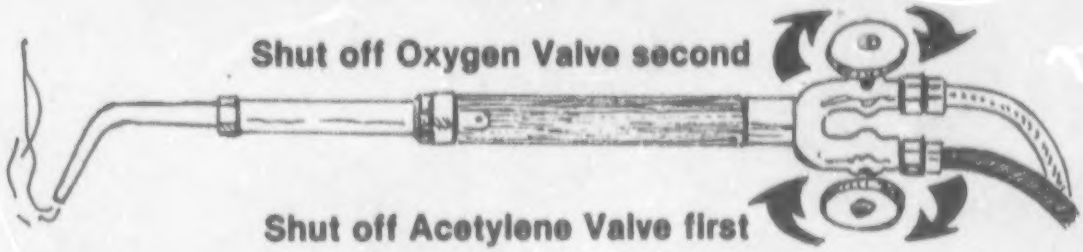
NOTE!

Direct the flame at a 90° angle to the surface by the joint. Otherwise the molten brazing rod will spread over the edge of the top base metal.

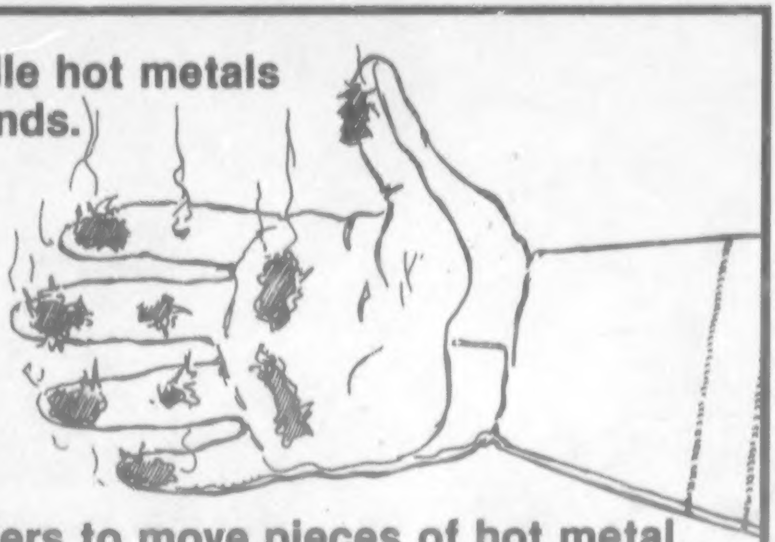
14. Braze the entire length of the joint. Keep welding torch tip at the correct angle.



15. After brazing the entire joint shut off the welding torch.

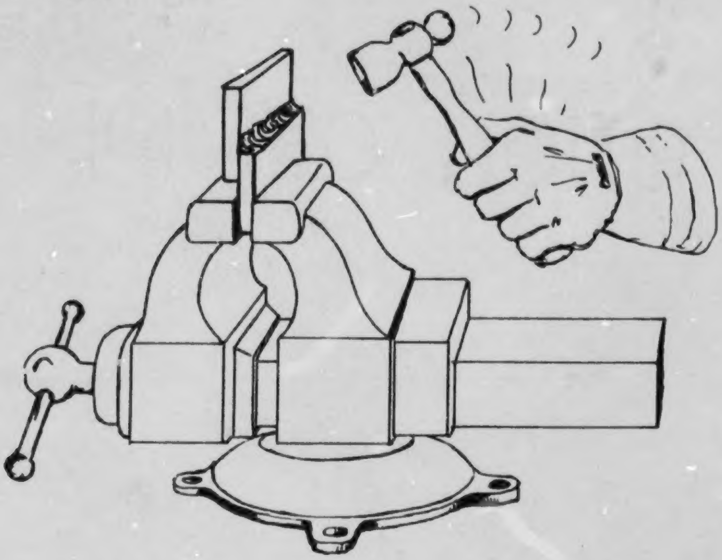

Shut off Oxygen Valve second
Shut off Acetylene Valve first

CAUTION!
NEVER handle hot metals with your hands.



ALWAYS use pliers to move pieces of hot metal.

16. Allow the metal to cool before you handle or move it. Test the strength of the brazed lap joint with a jig or metal vise.



17. Clean your work area. Return tools and materials to their proper places.

SEE YOUR INSTRUCTOR

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Unit 7
Brazing a Lap Joint

Practical Exercise Performance Checklist

The student ____________________ sucessfully performed the following tasks:

Tasks	Yes	No	Comments
1. Wore proper safety equipment			
2. Obtained the pieces of base metals to be brazed and properly cleaned them			
3. Correctly positioned the base metals on the welding table			
4. Selected and attached the correct torch tip			
5. Lighted and adjusted the torch to an oxidizing flame			
6. Treated the end of the brazing rod with heat and flux			
7. Tack welded the base metals			
8. Preheated a spot on the base metals to be brazed			
9. Melted some flux from the rod into the joint corner			
10. Heated both metal pieces evenly to enhance uniform bonding			
11. Melted the brazing rod into the heated joint and began brazing			
12. Correctly held the torch and the brazing rod while brazing the entire joint			
13. Shut off the torch after the work was completed			
14. Safely moved or handled the hot metal			
15. Tested the strength of the brazed joint after allowing it to cool			
16. Cleaned work area and returned tools and materials to proper places			

Satisfactory Performance ☐
Repeat Exercise ☐
Should Move On ☐

Instructor's Signature ______________________ date ______________

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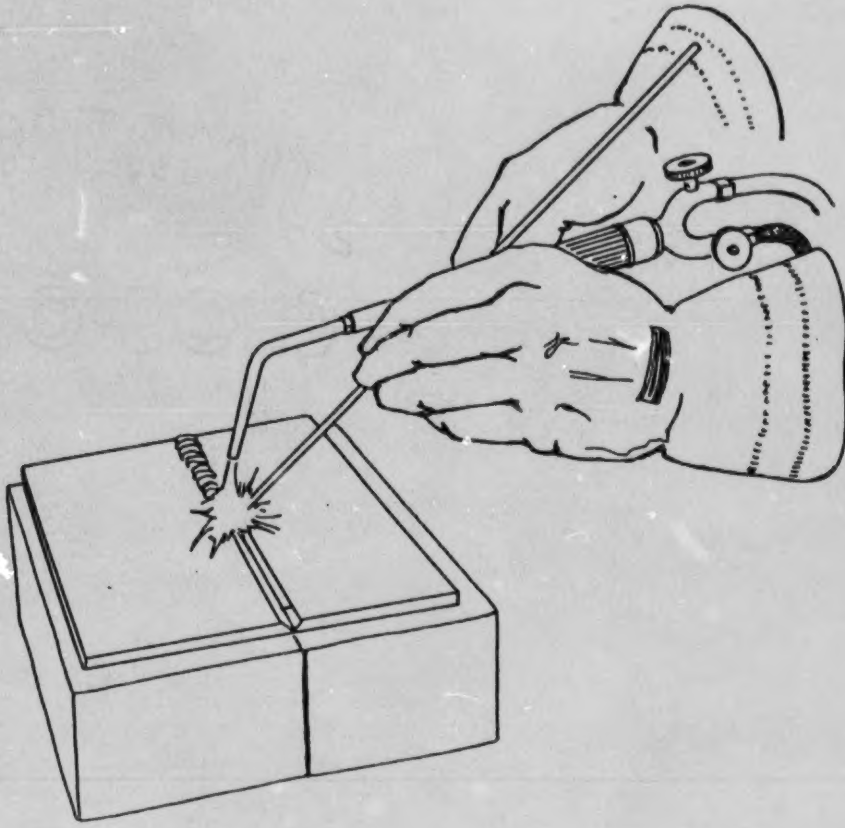
Vocational Preparation Curriculum
WELDING



Unit 8

Flame Cutting Metal

Developed by: Hogan Usoro

PRACTICAL ARTS
AND
VOCATIONAL-TECHNICAL
EDUCATION
iml
INSTRUCTIONAL MATERIALS LABORATORY
UNIVERSITY OF MISSOURI-COLUMBIA

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Unit 8
Flame Cutting Metal

Flame Cutting Metal

After you study this lessson, you should be able to:

1. Light a cutting torch.
2. Flame cut a given metal piece.

Show What You Can Do.

Check the statement that fits you best.

1. ☐ **I can do all the tasks above and want my instructor to give me the Practical Exercise.**

SEE YOUR INSTRUCTOR

2. ☐ **I want to study the information in this unit before I do the Practical Exercise.**

TURN THE PAGE AND BEGIN

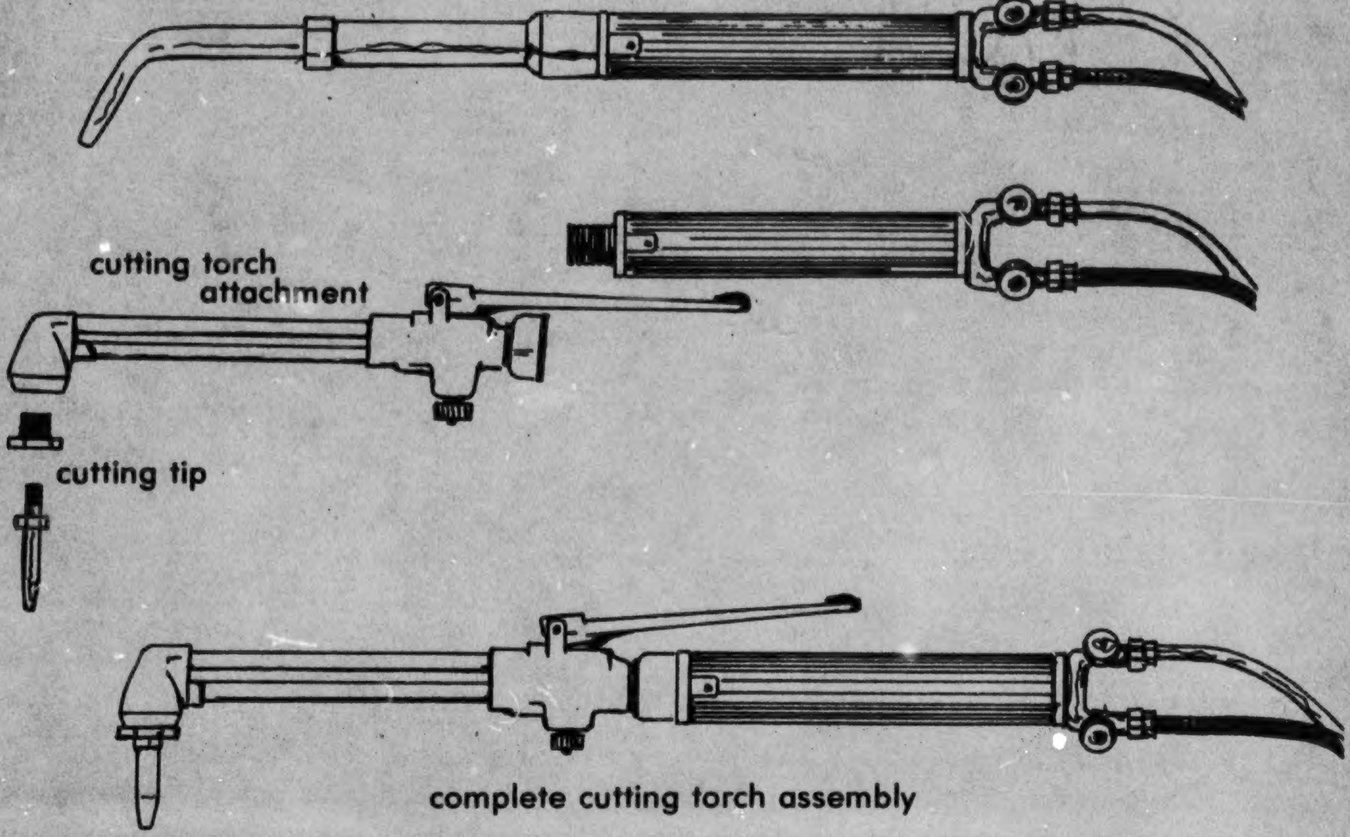
Unit 8
Flame Cutting Metal

Introduction

You will use a welding torch with a cutting attachment to cut metals in this lesson. This is called Flame Cutting Metal.

Flame cutting metal is by far faster and less tiring than cutting metal with a hacksaw.

It is hoped that you will find this lesson interesting.

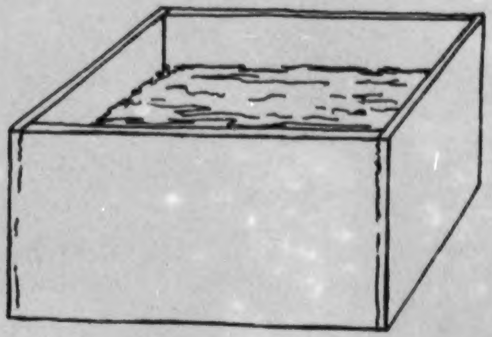

cutting torch attachment
cutting tip
complete cutting torch assembly

TURN TO NEXT PAGE

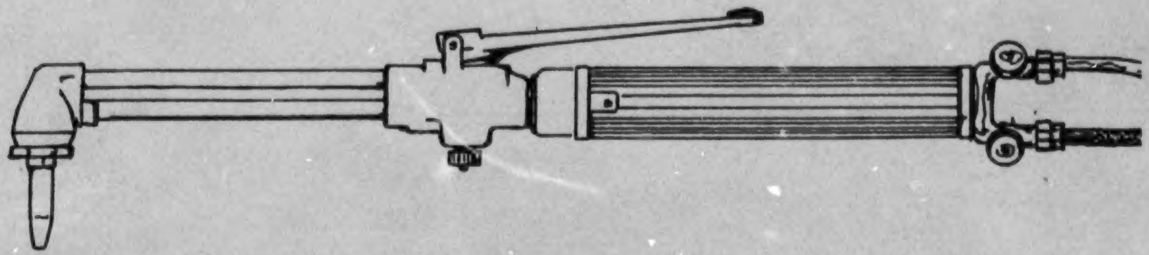
Unit 8
Flame Cutting Metal

A. Tools, Materials and Equipment for Flame Cutting Metal.

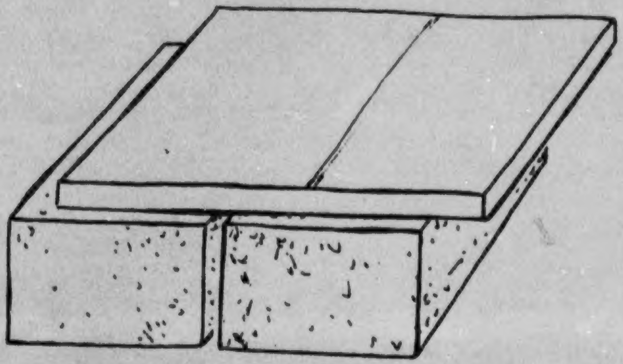
1. **SCRAP BOX:** A metal box used to catch and store slag. Slag is metal ash formed as you cut or weld metal.



2. **CUTTING ATTACHMENT:** Device which controls the flame for cutting metals.



3. **FIREBRICKS:** Bricks used for support in welding and cutting.



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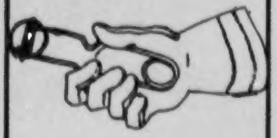
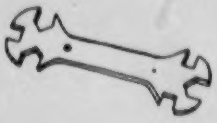
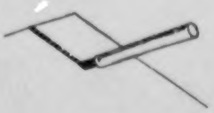
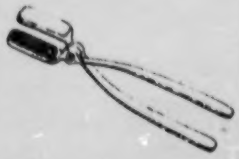
B. Procedure for Flame Cutting Metal.

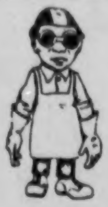
1. Find and Check Off the following:

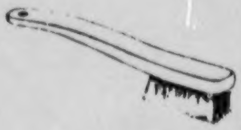

☐ Sparklighter

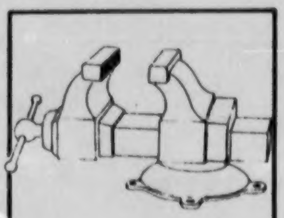

☐ Torch Tip Wrench

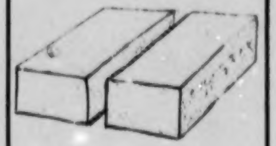

☐ Soapstone

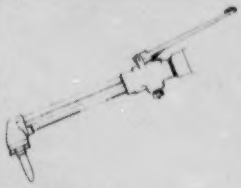

☐ Pliers

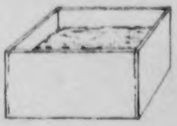

☐ Safety Equip.

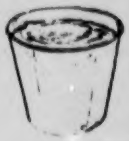

☐ Wire Brush


☐ Vise

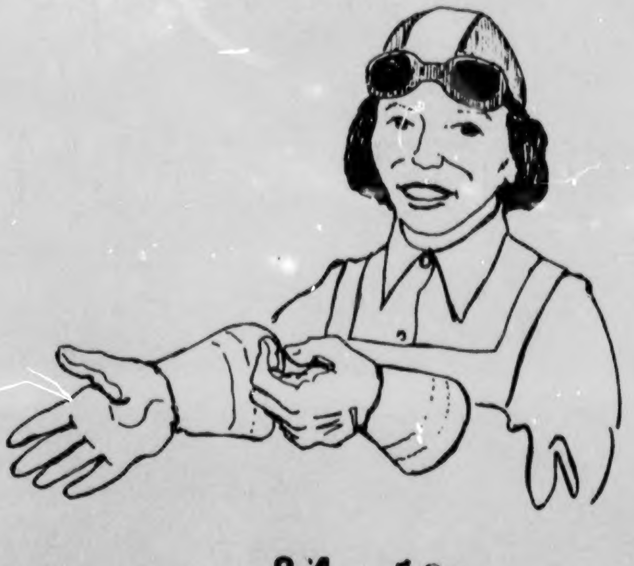

☐ Firebricks


☐ Cutting Torch

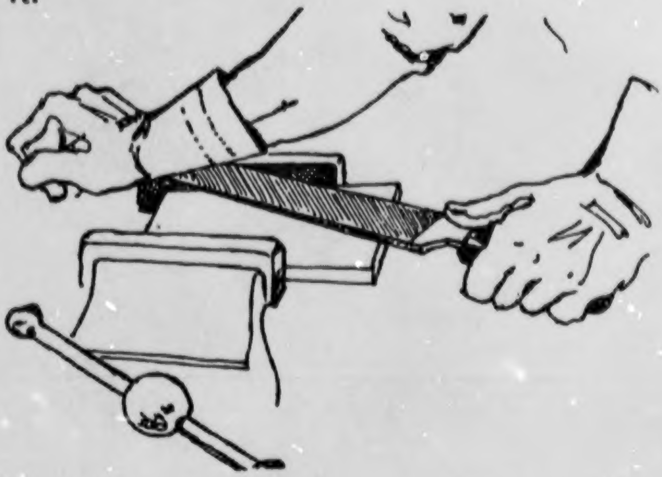

☐ Scrap Box


☐ Water Bucket

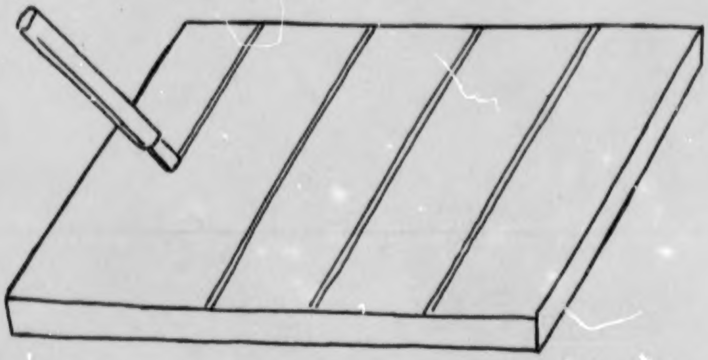
2. Be sure to wear proper safety equipment.



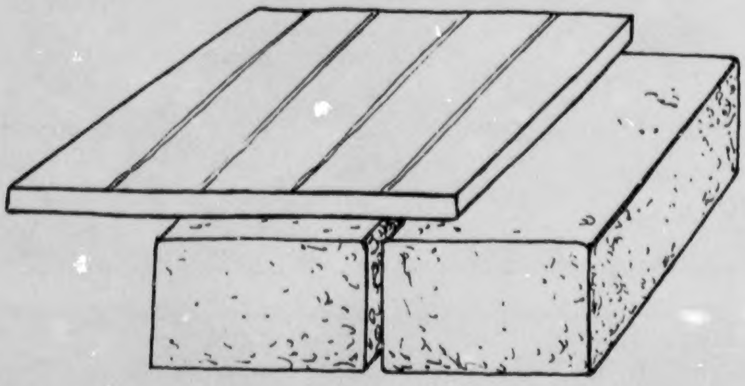
3. Obtain a piece of base metal 1/2"x 6"x 8". Secure it in the vise and properly clean it.



4. With a soapstone marker draw four parallel lines on the metal base.



5. Place the metal plate on the bricks so that one edge overhangs.



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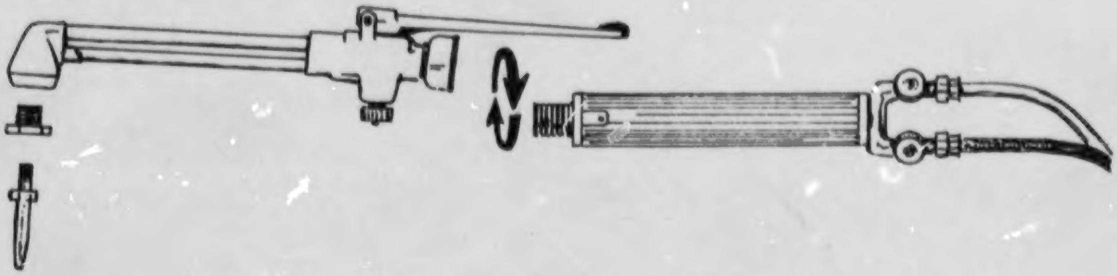
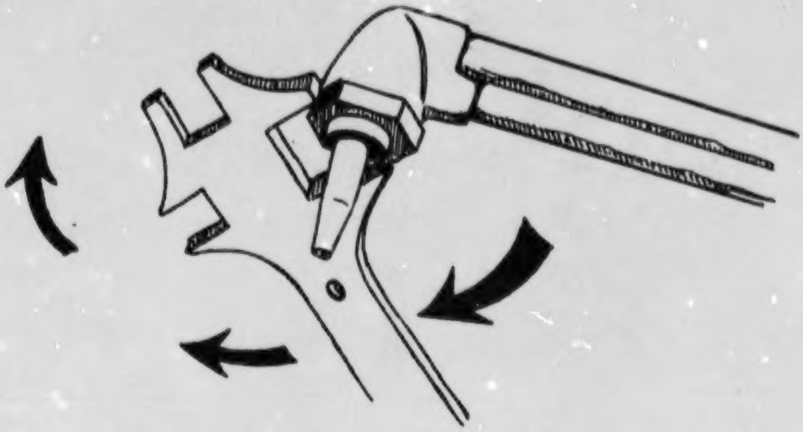
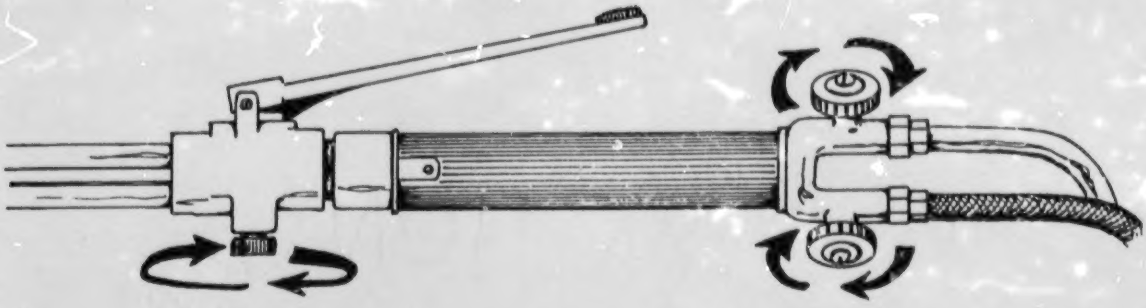
6. Install the cutting torch attachment to the torch body. Tighten it with your hand by turning it to the right.



7. Attach a Number 1 cutting tip. Tighten the tip with the torch tip wrench by turning to the right.



8. Close the three valves on the torch by turning each to the the right.

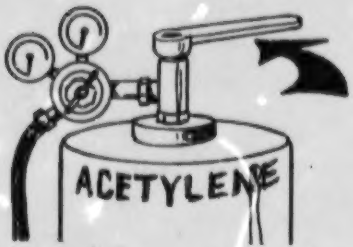


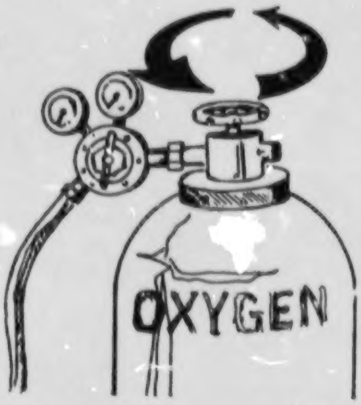
NOTE!

Check the gas welding equipment to make sure the regulator handles and valves are off.

9. Turn the acetylene cylinder valve with a wrench 1/4 to 1/2 turn to the left.

   Turn the oxygen cylinder valve to the left all the way.

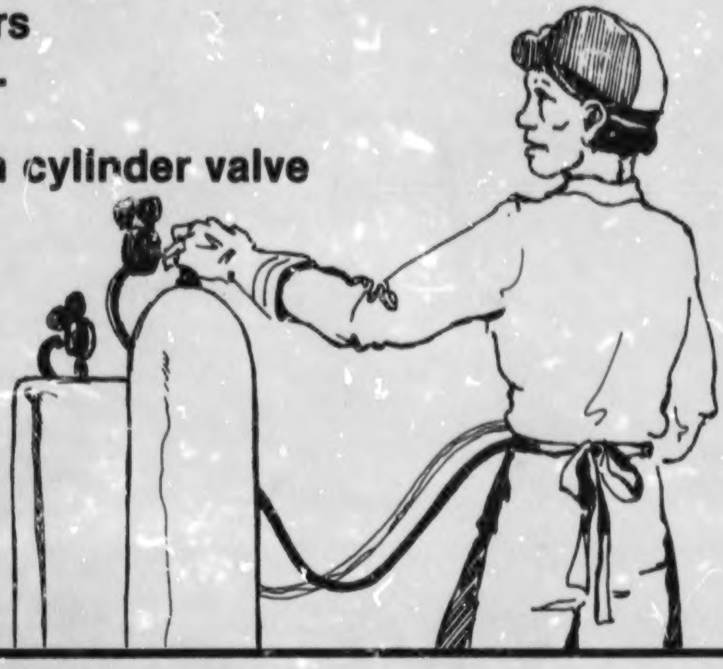




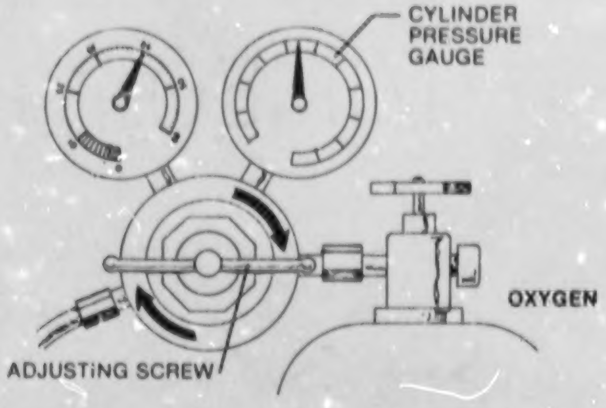
CAUTION!

ALWAYS stand to one side of the cylinders when opening.

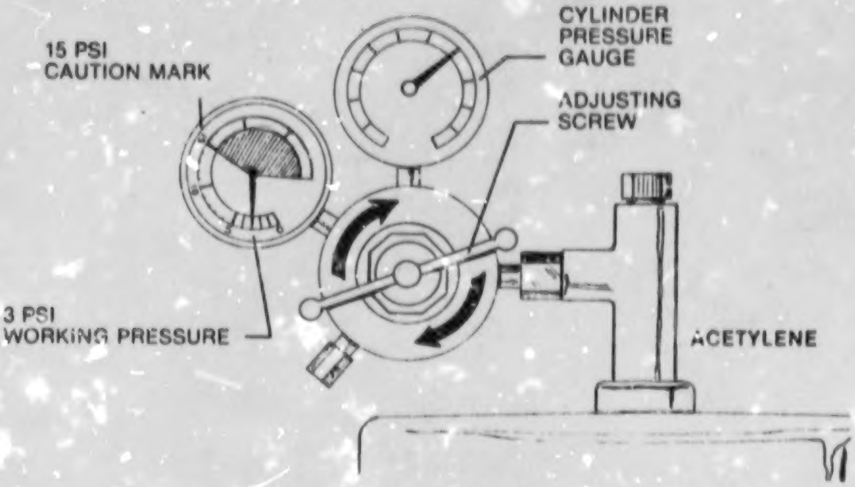
ALWAYS open cylinder valve slowly.



10. Set the oxygen working pressure gauge to 25 pounds per square inch by turning the adjusting screw to the right.


CYLINDER PRESSURE GAUGE
OXYGEN
ADJUSTING SCREW

11. Set the acetylene working pressure gauge to 5 pounds per square inch by turning that adjusting screw to the right also.

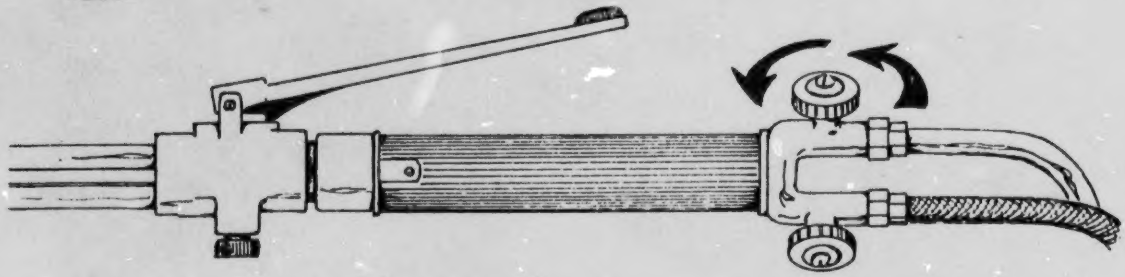

CYLINDER PRESSURE GAUGE
15 PSI CAUTION MARK
ADJUSTING SCREW
3 PSI WORKING PRESSURE
ACETYLENE

CAUTION!

NEVER exceed 15 pounds per square inch on the acetylene working gauge or it can explode.

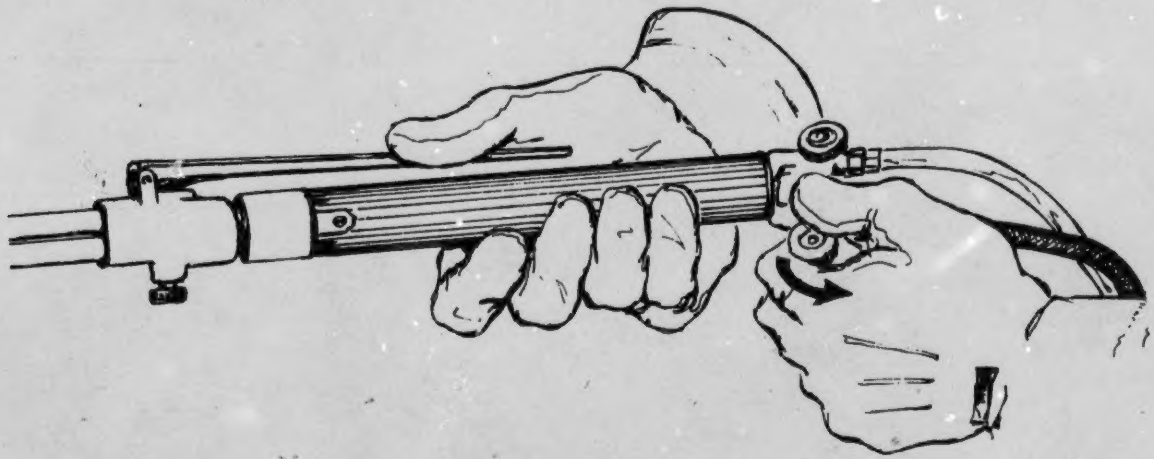
ALWAYS check tip for proper size before cutting.

12. Turn the oxygen needle valve on the torch all the way to the left.

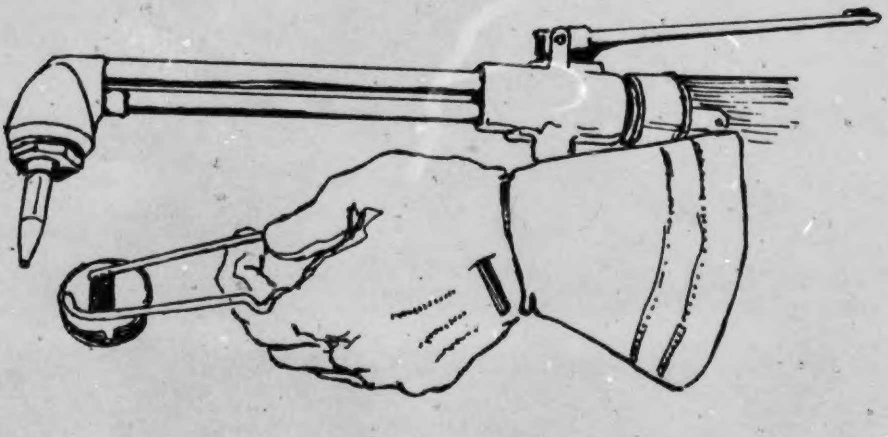


13. Press the oxygen cutting lever to clean the center hole in the cutting tip, then release the lever.

    Turn the acetylene needle valve about 1/4 of a turn to the left.



14. Light the cutting torch.



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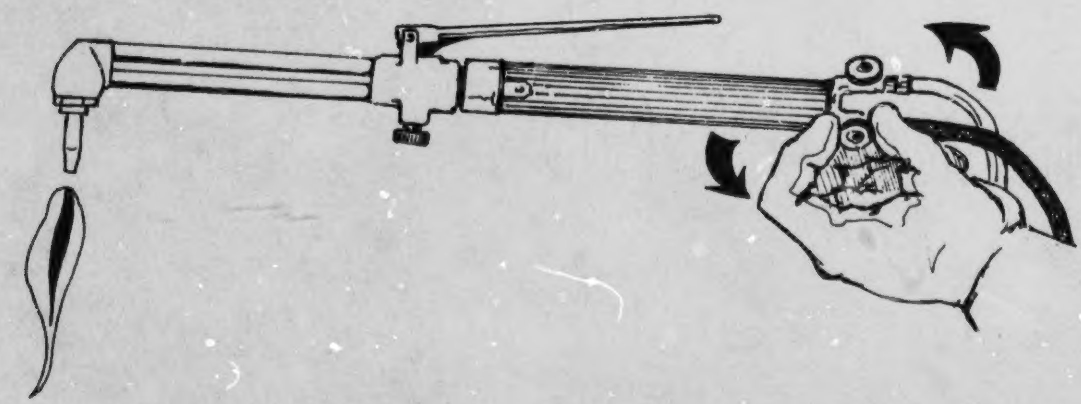
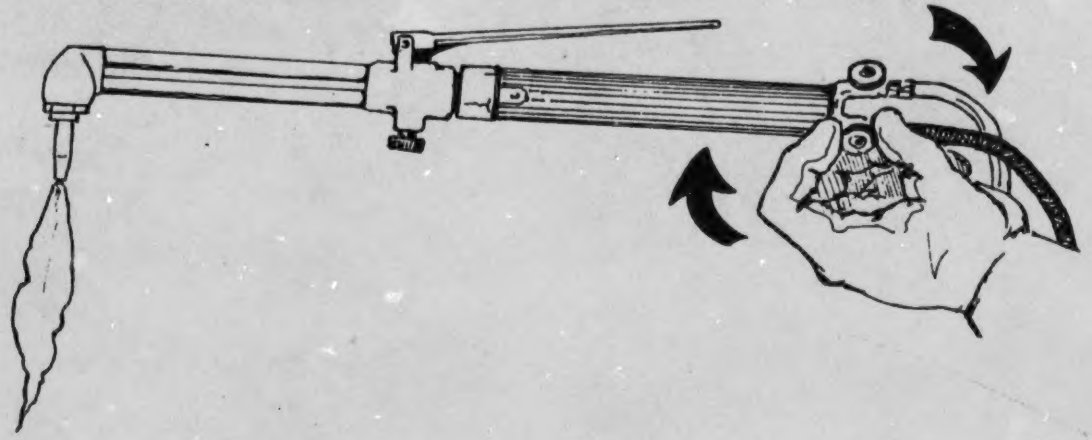
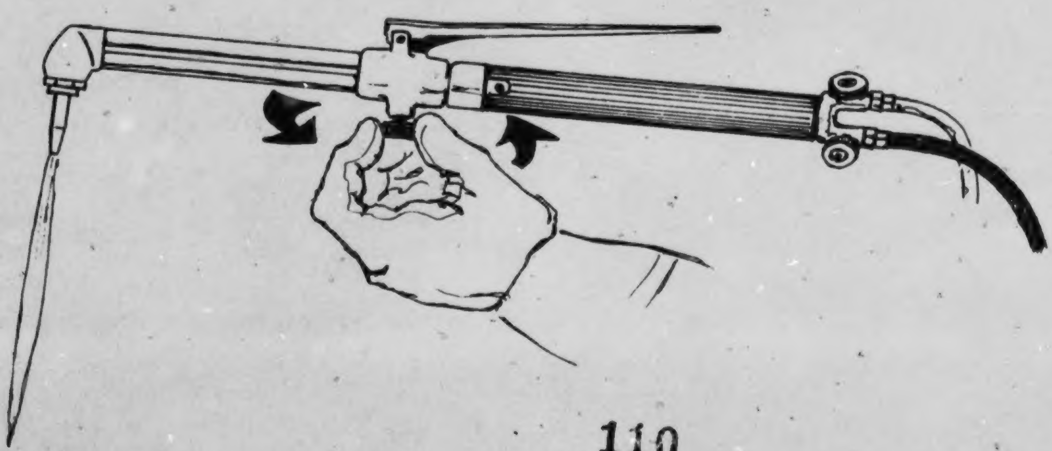
15. Turn the acetylene needle valve more to the left until the flame tends to jump about 1/8" from the tip end.



16. Turn the acetylene needle valve back to the right to bring the flame back to the tip.



17. Turn the oxygen preheating valve slowly to the left until a neutral flame is obtained.



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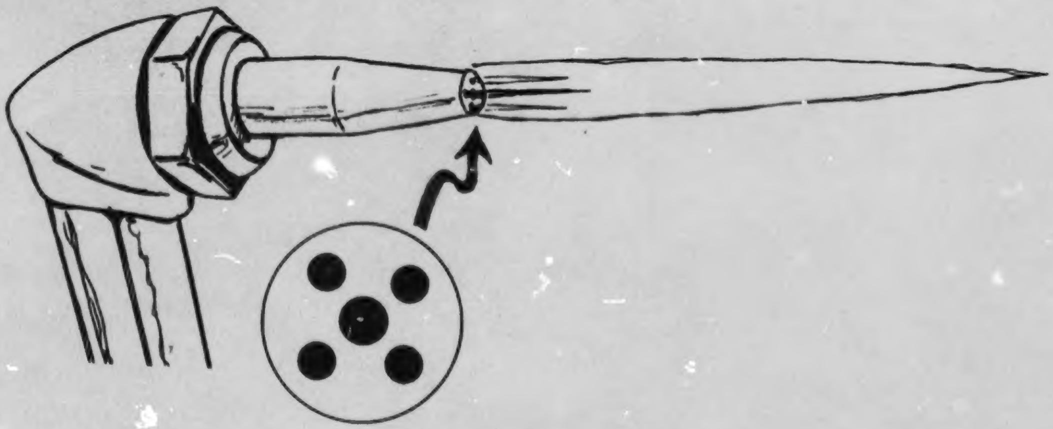
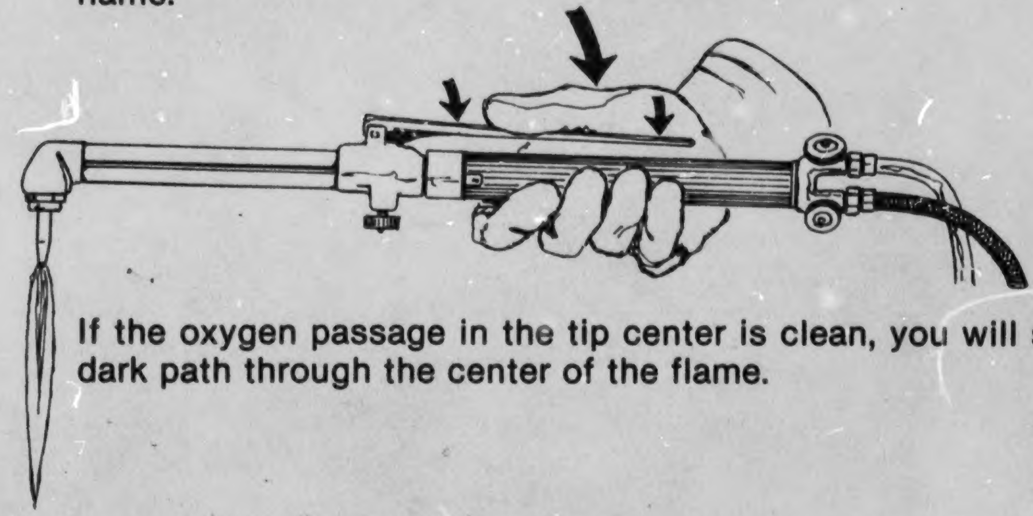
Look for a neutral flame in each preheat hole.

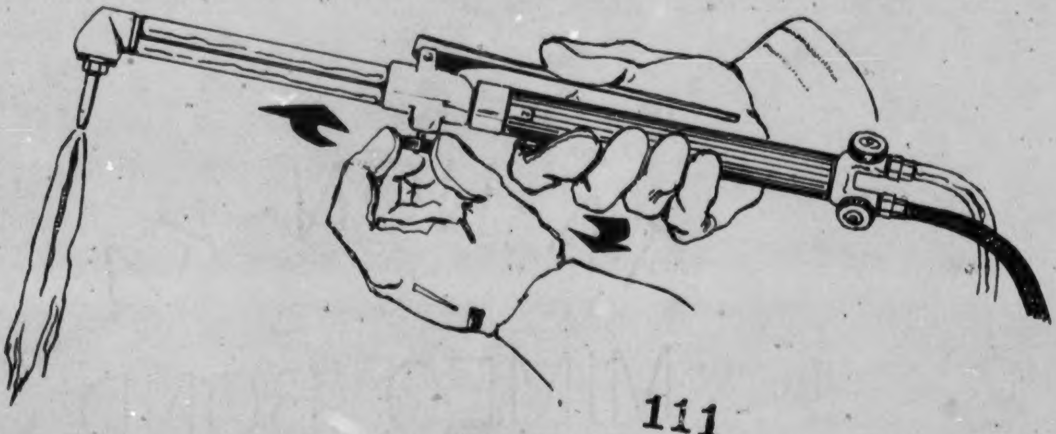


18. Press the oxygen cutting valve handle and observe the heating flame.



If the oxygen passage in the tip center is clean, you will see a dark path through the center of the flame.

19. If the preheating flame grows larger, continue to press the oxygen cutting lever. At the same time turn the oxygen preheat valve slowly to the right until the flame becomes neutral again.



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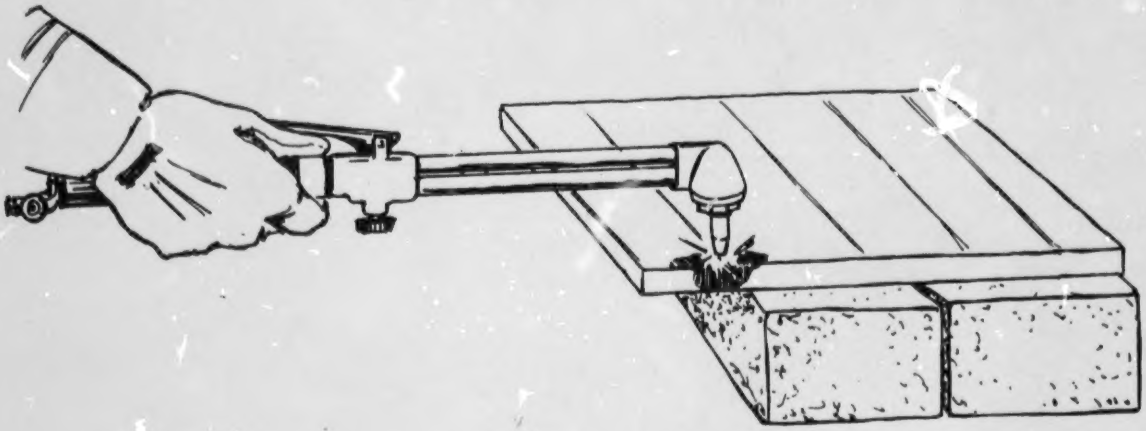
Release the oxygen cutting lever to close the oxygen cutting valve.

CAUTION!

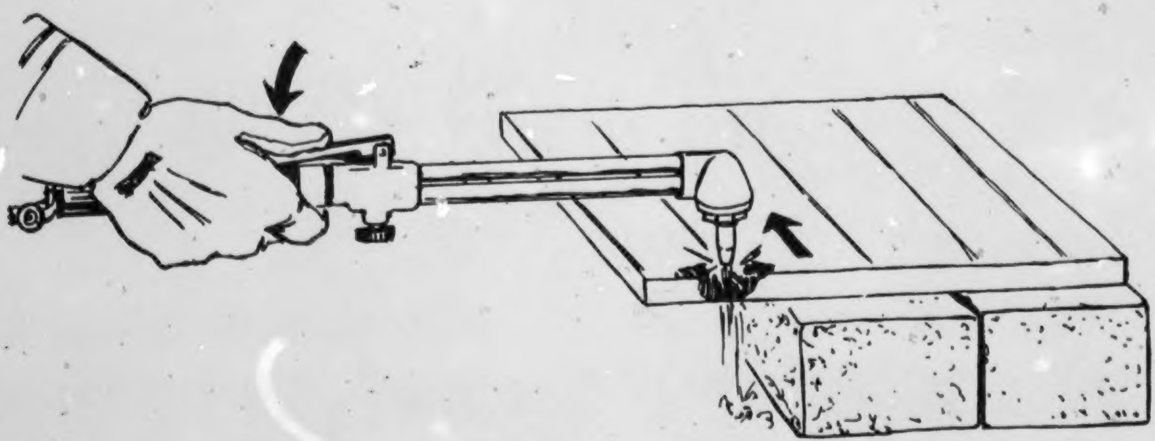
Keep hoses away from the flame.

Remove flammable materials from the cutting area.

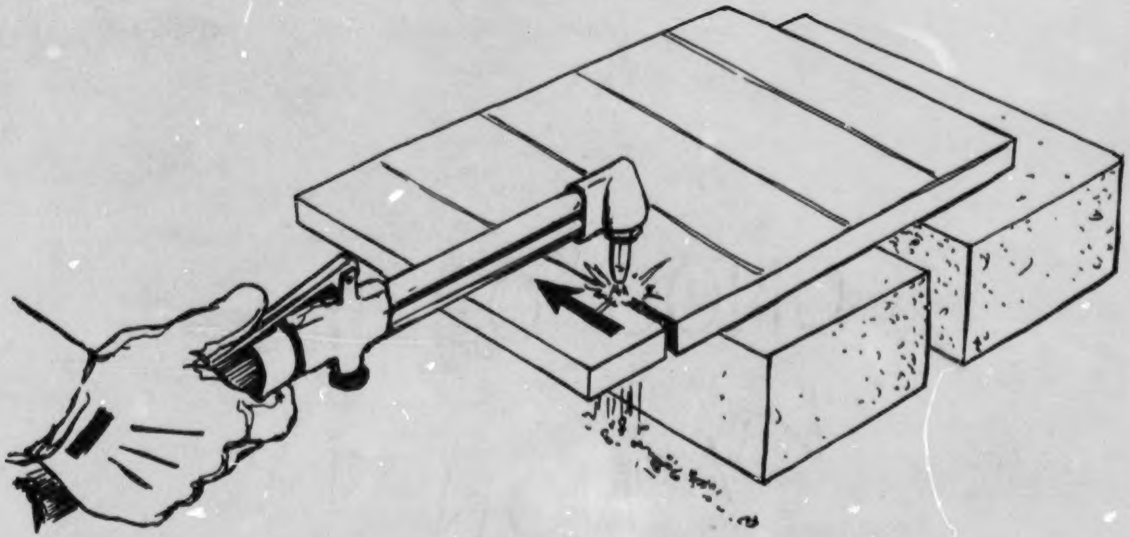
20. Hold the torch tip at a 90° angle to the cutting surface. Place the inner flame cones about 1/8" above the metal plate. Hold here until the metal is heated red hot.



21. Depress the oxygen cutting lever. Begin to cut along the soapstone line.



22. Cut at a steady speed. If the speed is correct, the slag produced will appear under the base metal.



23. Cut along the remaining lines.

24. When finished, release the oxygen cutting lever. Shut off the torch as follows:

    a. Close the acetylene needle valve.

    b. Close the oxygen needle valve and the preheat valve.

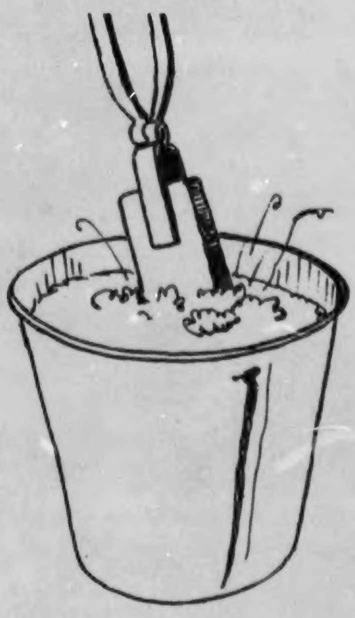
    c. Close the acetylene tank valve.

    d. Close the oxygen tank valve.

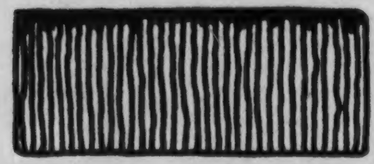
    e. Drain the hoses.

    f. Release the acetylene regulator adjusting screw and the oxygen regulator adjusting screw.

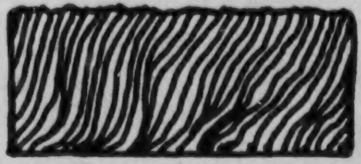
25. Cool the cut pieces of metal in a container of water.



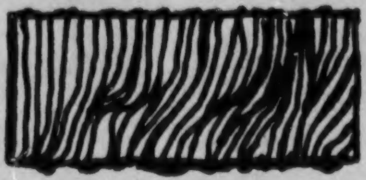
26. Now compare the edge of your cut metal to these pictured below.



CORRECT CUTTING SPEED



CUT TOO FAST



CUT TOO SLOW

Check the cutting speed you think you used.

☐ TOO SLOW ☐ TOO FAST ☐ CORRECT SPEED

27. Put the slag and other waste materials into the scrap box and clean your work area.

SEE YOUR INSTRUCTOR

Unit 8
Flame Cutting Metal

Practical Exercise Performance Checklist

The student ______________________ successfully performed the following tasks:

Tasks	Yes	No	Comments
1. Wore proper safety equipment			
2. Properly cleaned the base metal to be cut			
3. Marked lines on the base metal to guide flame cutting			
4. Properly positioned the base metal on the fire bricks			
5. Selected and installed cutting attachment (optional for students to perform)			
6. Selected and attached proper cutting tip (optional for students to perform)			
7. Checked the welding equipment before lighting it			
8. Safely opened the acetylene cylinder valve			
9. Safely opened the oxygen cylinder valve			
10. Stood to one side while opening the cylinders			
11. Properly set the oxygen working pressure gauge			
12. Properly set the acetylene working pressure gauge			
13. Opened the oxygen needle valve all the way			
14. Pressed the oxygen cutting lever to purge the large orifice in the center of the cutting tip			

Tasks	Yes	No	Comments
15. Properly opened the acetylene needle valve (1/6 to 1/4 of a turn)			
16. Lighted the torch with a spark lighter.			
17. Adjusted the acetylene torch valve until flame tended to jump about 1/8" from the tip			
18. Readjusted the torch to bring flame back to the tip			
19. Slowly opened the oxygen preheat valve to obtain a neutral flame			
20. Pressed the oxygen cutting lever to obtain the preheating flame			
21. Readjusted the oxygen preheat valve to maintain a neutral flame			
22. Kept hoses and all flammable materials away from the flame			
23. Closed the oxygen cutting valve			
24. Held the cutting torch tip at right angle to the work			
25. Preheated the base metal to red hot			
26. Slowly depressed the oxygen cutting lever and cut plate along the soapstone chalk lines			
27. Maintained correct cutting speed			
28. Correctly shut off the torch			
29. Safely handled the hot metal			
30. Cleaned work area			

Satisfactory Performance ☐
Repeat Steps of Procedure ☐
Should Move On ☐

Instructor's Signature ____________ date ____________

Vocational Preparation Curriculum
WELDING

Unit 9

Safety Rules in Arc Welding

Developed by: Hogan Usoro

PRACTICAL ARTS
AND
VOCATIONAL-TECHNICAL
EDUCATION
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UNIVERSITY OF MISSOURI-COLUMBIA

Unit 9
Safety Rules in Arc Welding

Safety Rules in Arc Welding

After you have studied this lesson, you should be able to:

1. Identify an unsafe environment or situation for arc welding.
2. Perform safely in a welding shop and during arc welding exercises.

Show What You Can Do.

Check the statement that fits you best.

1. ☐ **I can do all the tasks above and want my instructor to give me the Practical Exercise.**

SEE YOUR INSTRUCTOR

2. ☐ **I want to study the information in this unit before I do the Practical Exercise.**

TURN THE PAGE AND BEGIN

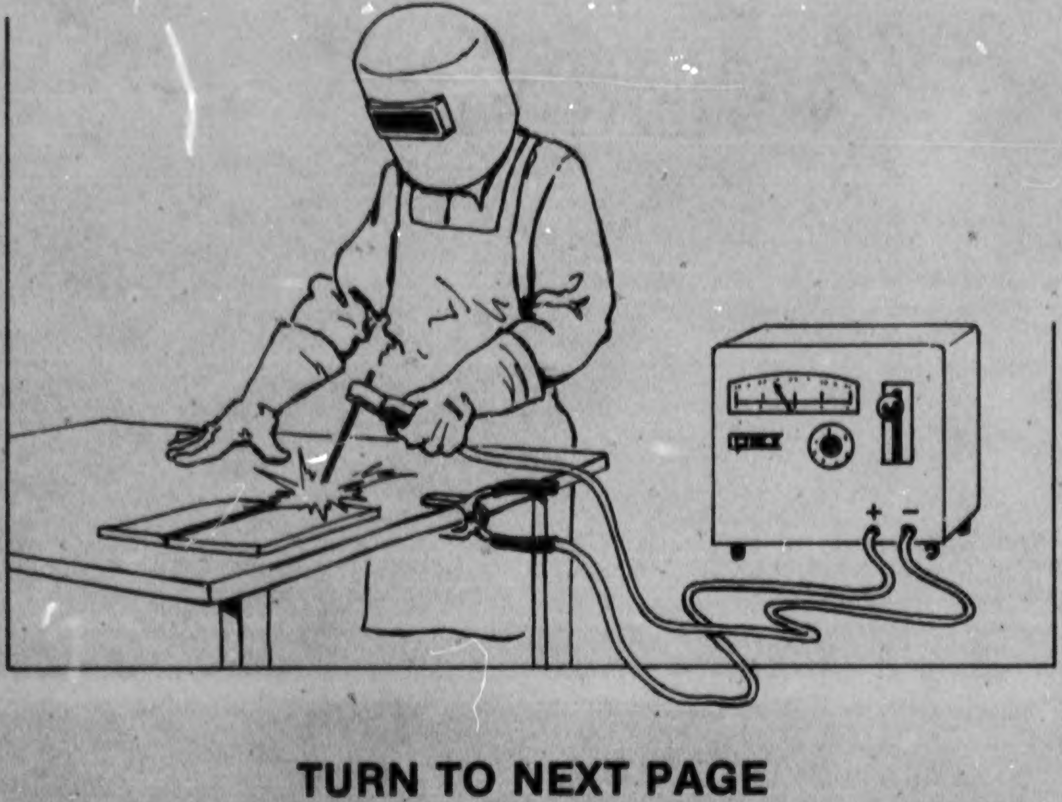
Unit 9
Safety Rules in Arc Welding

Introduction

Before you began to do gas welding, you studied gas welding safety rules. Now that you are ready to begin arc welding these same safety rules plus a few more are just as important.

Electrical currents are used in arc welding. If not handled carefully electricity can cause severe burns and shock. The bright flash of the welding arc can also damage your eyes. You must be very careful as you do electrical welding.

In this lesson you are going to learn about some safety rules in arc or electrical welding. The picture shows a safe arc welding situation. Always think of your safety while in the workshop or on the job site.

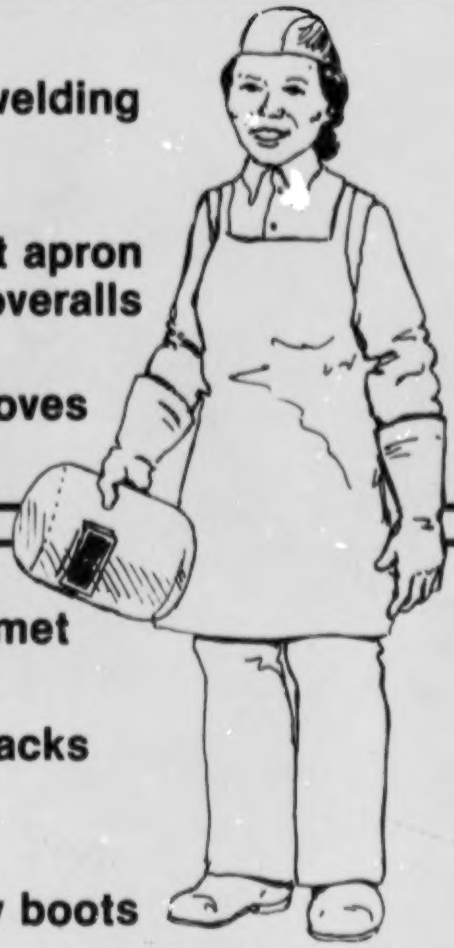


TURN TO NEXT PAGE

Unit 9

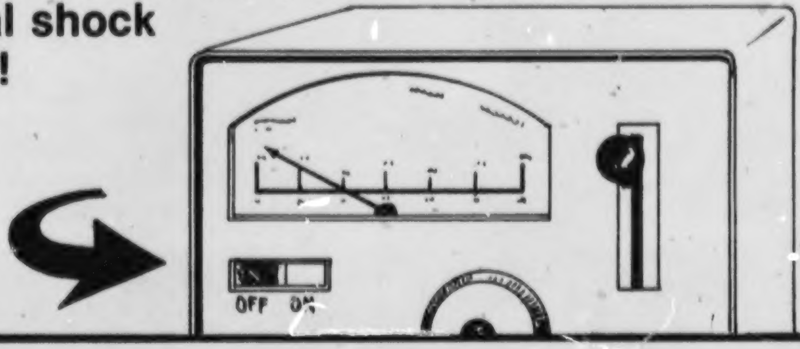
Safety Rules in Arc Welding

Always wear proper arc welding safety equipment!


fire resistant apron
or coveralls
gloves
helmet
heavy boots

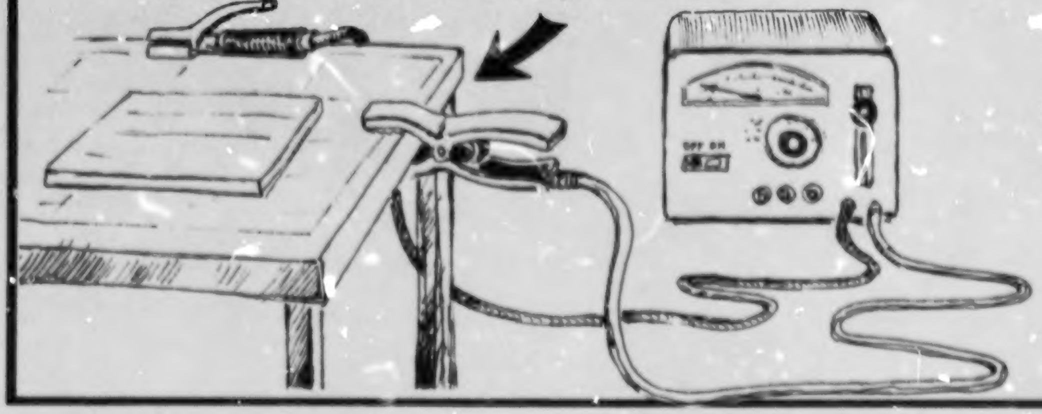
Check helmet lens for cracks before your use it!

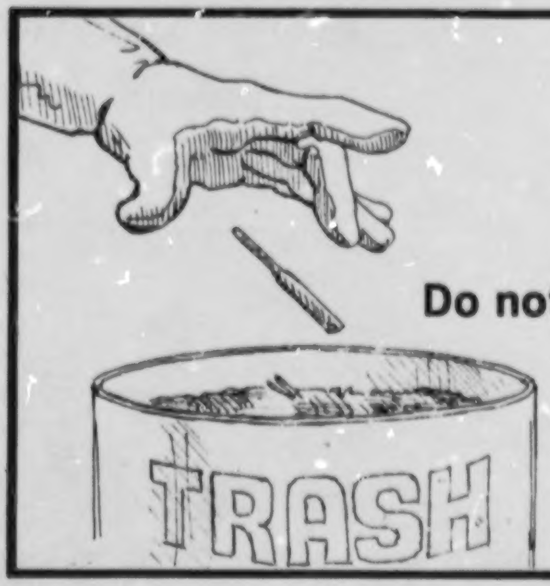
Always switch the welding machine off when work is completed to prevent electrical shock or burns!



Safety Rules in Arc Welding

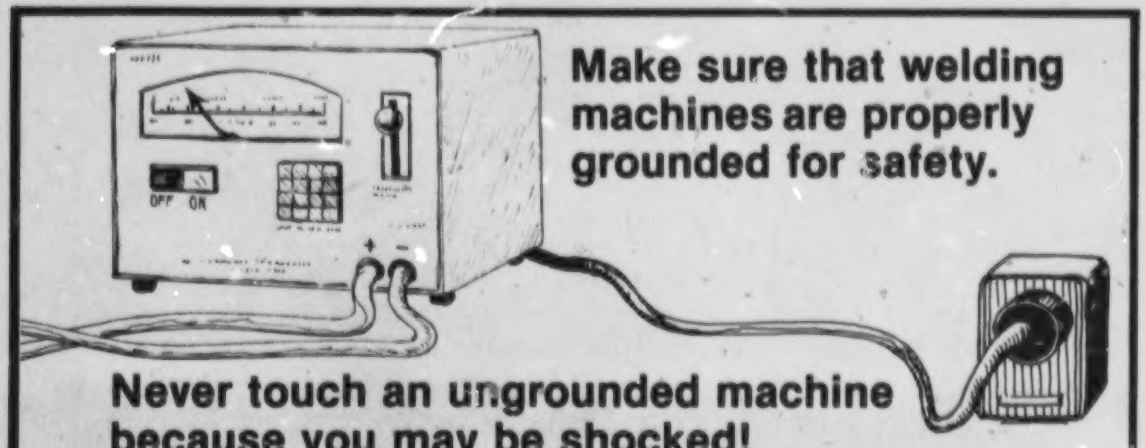
Always ground the work piece for your safety and the safety of others!





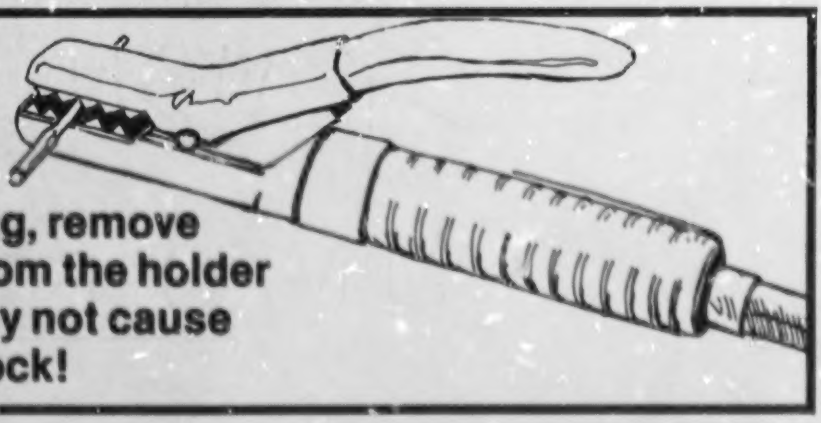
Put electrode stubs in a waste container. Do not throw them on the floor!

Make sure that welding machines are properly grounded for safety.

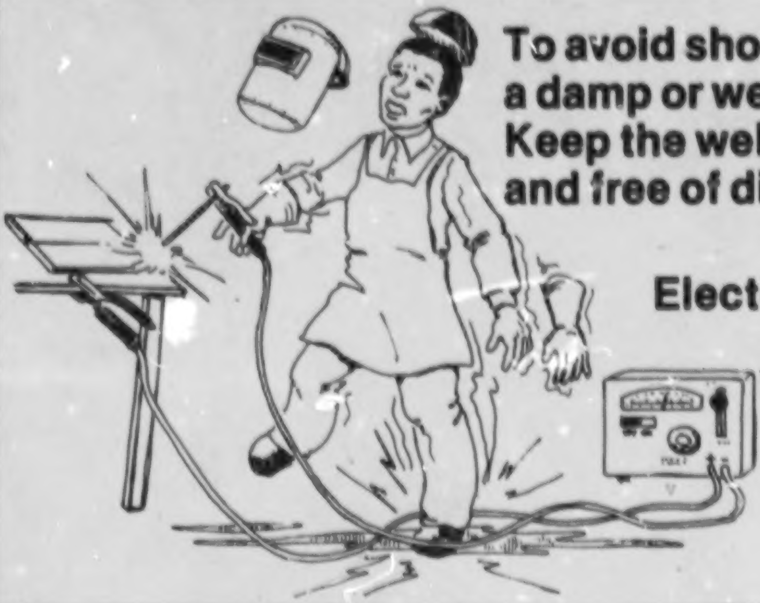


Never touch an ungrounded machine because you may be shocked!

Safety Rules in Arc Welding

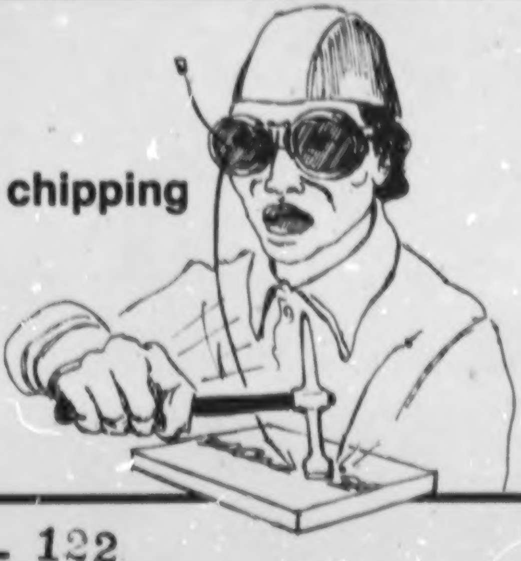


After welding, remove electrode from the holder so that it may not cause burns or shock!



**To avoid shock never weld in a damp or wet area.
Keep the welding cables dry and free of dirt and grease!**

Electricity can travel through water or grease!

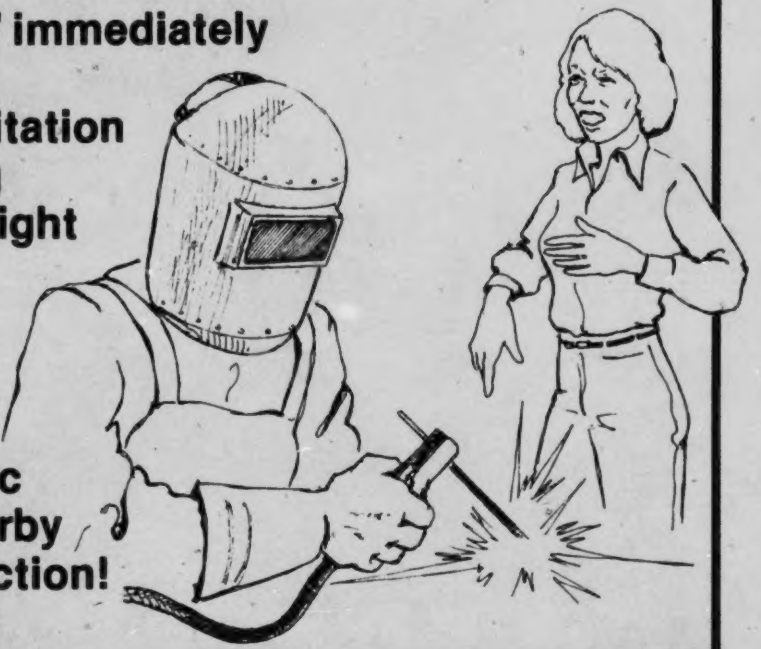


Wear safety goggles when chipping slag from the weld!

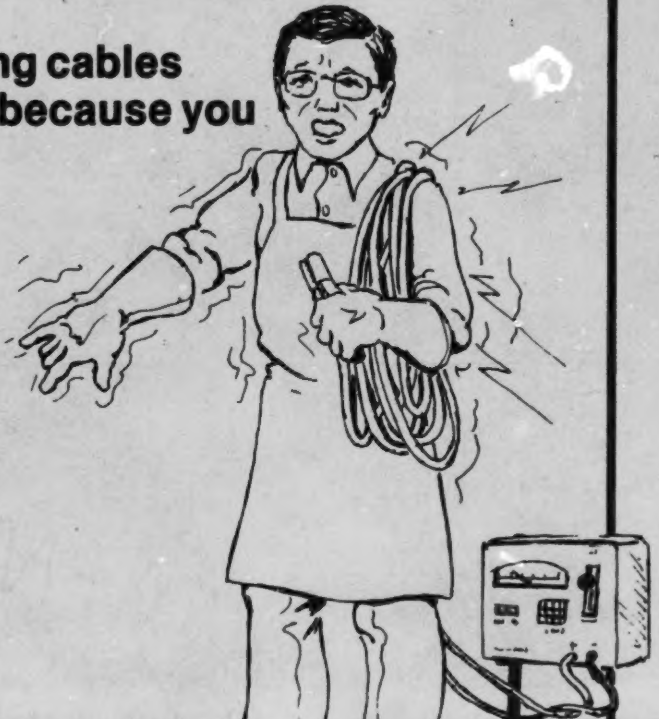
Safety Rules in Arc Welding

Report "eyeflash" immediately to your instructor. Eyeflash is eye irritation caused by looking at an arc welding light without eye protection!

Do not strike an arc if someone is nearby without eye protection!

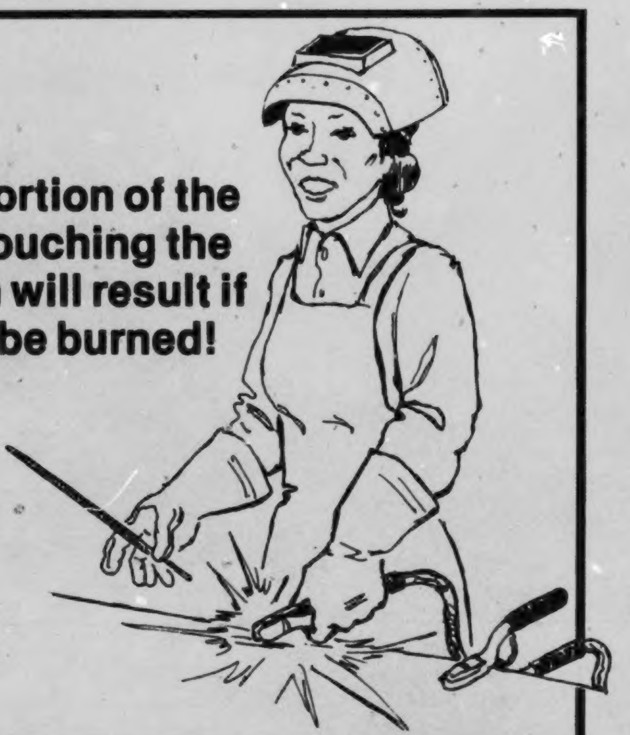


Never carry live welding cables around your shoulder because you can get shocked!

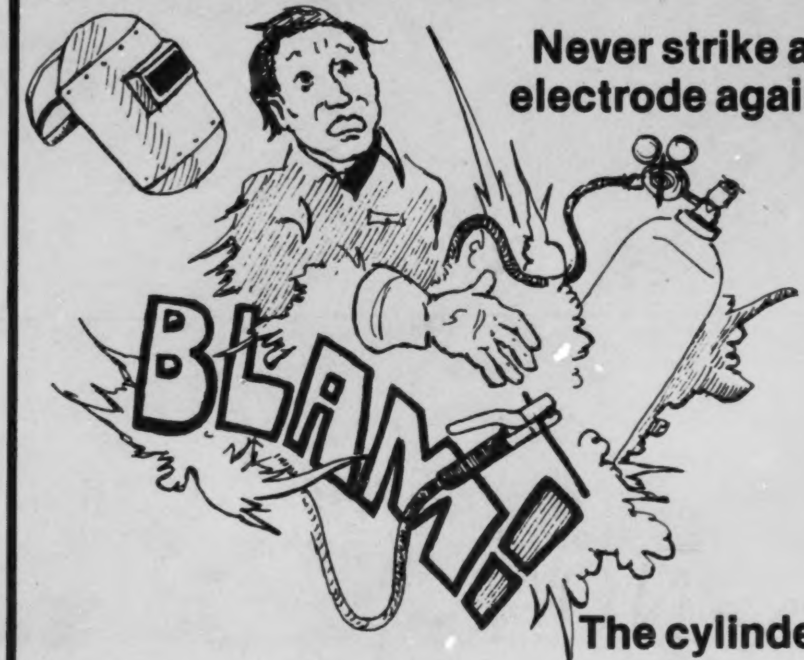


Safety Rules in Arc Welding

Keep the uninsulated portion of the electrode holder from touching the welding ground. A flash will result if it touches and you may be burned!



Never strike an arc or tap an electrode against a cylinder!



The cylinder can explode!

SEE YOUR INSTRUCTOR

Unit 9
Safety Rules in Arc Welding

Practical Exercise Performance Checklist

Student's Name: ____

True - False Questions:
Circle "T" if the statement is "True" and an "F" if it is "False."

T F 1. Always check your arc welding helmet before you use it.

T F 2. Always switch off the welding machine when a welding task is completed.

T F 3. Ground your work or welding table before starting to arc weld.

T F 4. It can be dangerous to leave the electrode in the electrode holder after welding.

T F 5. Never leave electrode stubs on the floor because they can cause accidents in the shop.

T F 6. It is important to keep an arc welding area and cables dry and free from dirt.

T F 7. Chipping slags from the weld or wire brushing metals is so easy that you do not need safety goggles while doing it.

T F 8. It is safe for you and other people to look at a welding arc without eye protection.

T F 9. Never allow the uninsulated portion of an electrode holder to touch the welding ground.

Satisfactory Performance ☐
Repeat Exercise ☐
Should Move On ☐

______________________ ____________
Instructor's Signature Date

Vocational Preparation Curriculum
WELDING

Unit 10

Striking an Arc

Developed by: Hogan Usoro

PRACTICAL ARTS
AND
VOCATIONAL-TECHNICAL
EDUCATION

iml

INSTRUCTIONAL MATERIALS LABORATORY
UNIVERSITY OF MISSOURI-COLUMBIA

Unit 10
Striking an Arc

Striking an Arc.

After you have studied this lesson, you should be able to:

1. Identify electrical welding tools, materials and equipment.
2. Strike an arc.

Show What You Can Do.

Check the statement that fits you best.

1. ☐ **I can do all the tasks above and want my instructor to give me the Practical Exercise.**

SEE YOUR INSTRUCTOR

2. ☐ **I want to study the information in this unit before I do the Practical Exercise.**

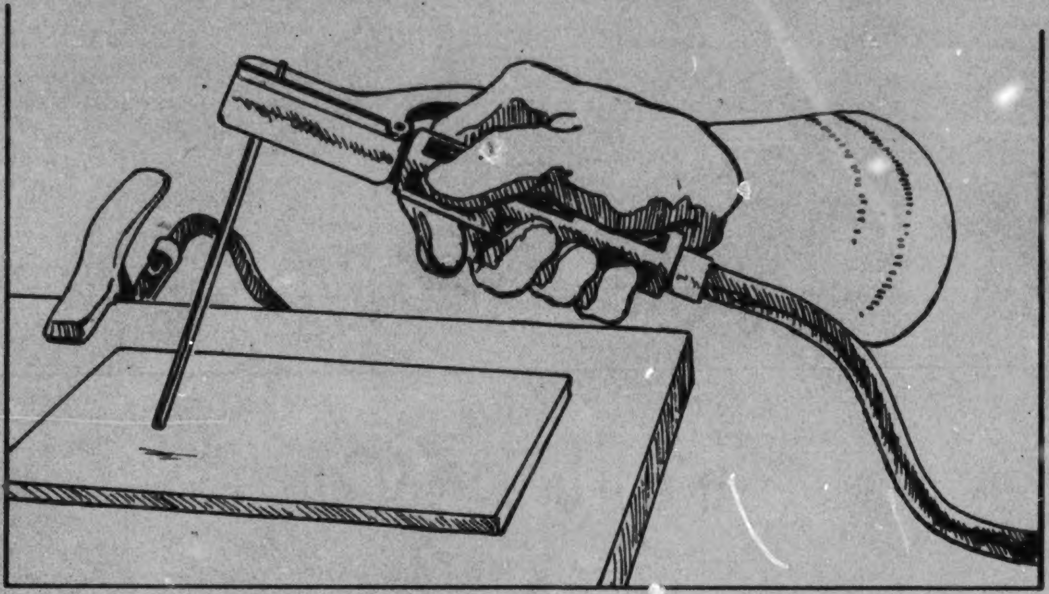
TURN THE PAGE AND BEGIN

Unit 10
Striking an Arc

Introduction

Arc welding is the joining of metals together using electrical heat. A metal rod called **electrode** is also used in arc welding. Electrical heat melts the electrode for welding.

The first thing to learn in arc welding is to strike a smooth arc without allowing the electrode to stick to the base metal. In this lesson you will learn how to strike an arc by moving the electrode in a scratching motion similar to striking a match.



It is hoped that you will find this lesson exciting! Now let us start.

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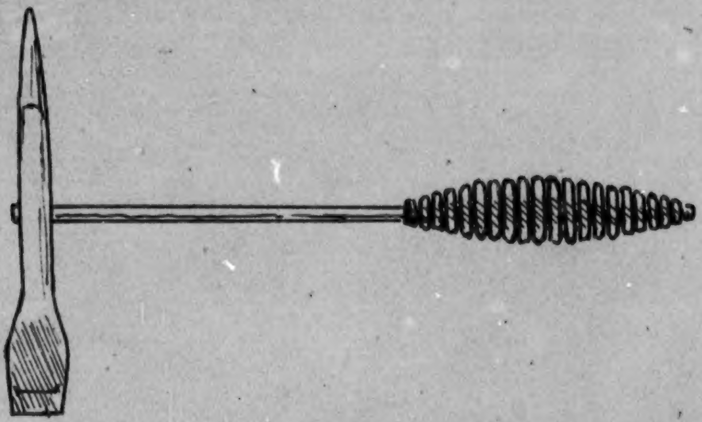
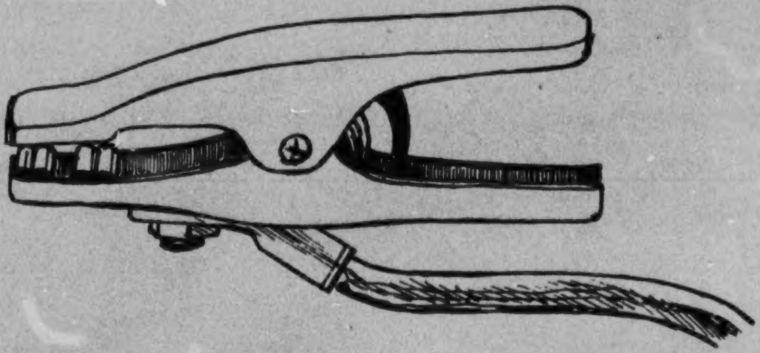
Unit 10
Striking an Arc

A. Tools, Materials and Equipment for Striking an Arc.

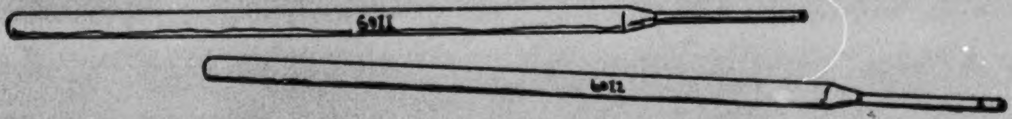
1. **CHIPPING HAMMER:** Used to remove slag from a weld.



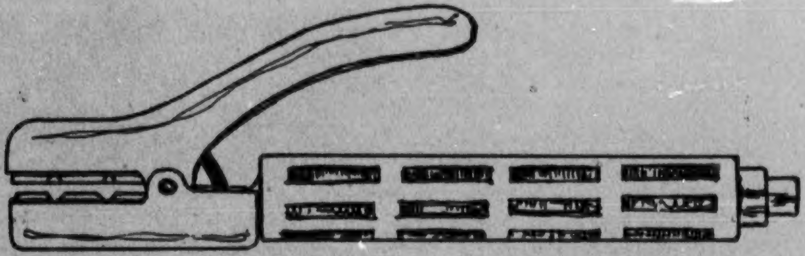
2. **GROUND CLAMP:** Electrical clamp used to connect ground cable to base metal or welding table for a ground connection.



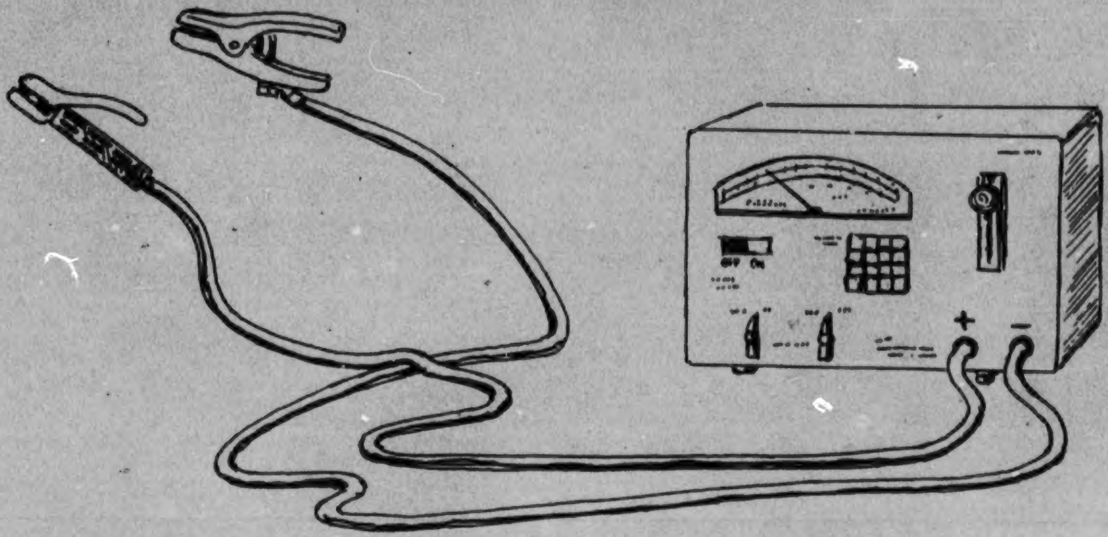
3. **ELECTRODE:** Metal rod which carries electric current from the electrode holder to the base metal and melts to create the weld.



4. **ELECTRODE HOLDER:** Used to hold the electrode and conduct electrical current for arc welding.



5. **WELDING MACHINE:** Supplies electrical power for arc welding.



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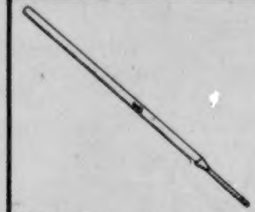
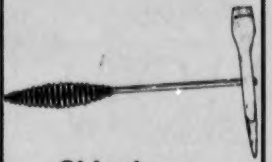
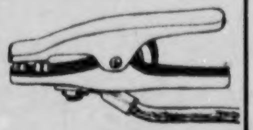
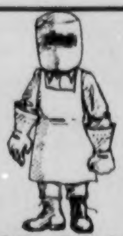
B. Steps for Striking an Arc

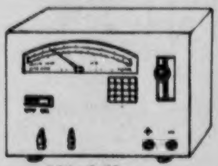
1. Find and Check Off the following:

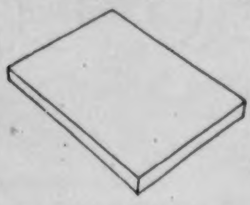

☐ **Electrode**

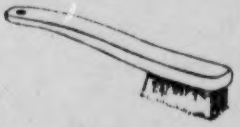

☐ **Chipping Hammer**

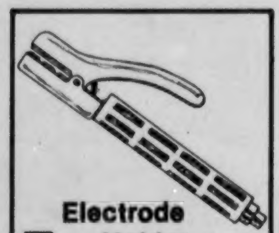

☐ **Ground Clamp**

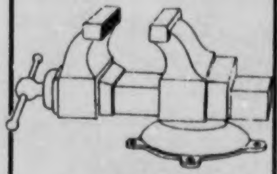

☐ **Safety Equip.**

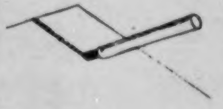

☐ **Welding Machine**


☐ **Base Metal**

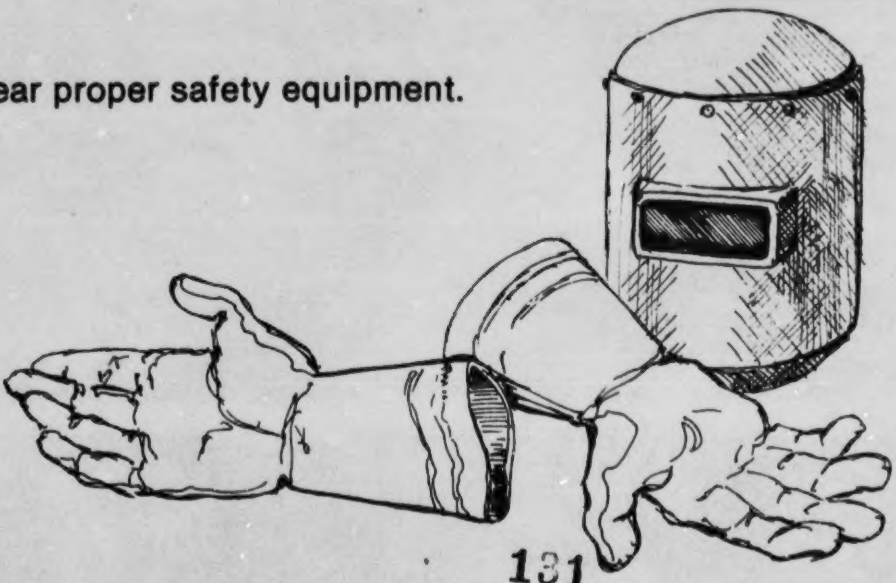

☐ **Wire Brush**


☐ **Electrode Holder**

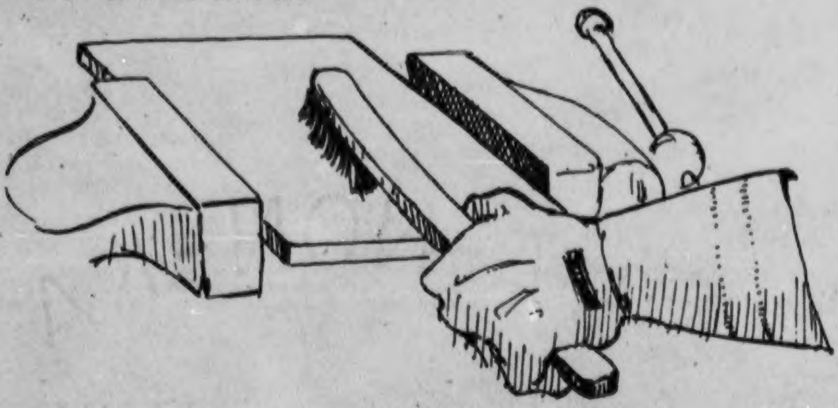

☐ **Vise**


☐ **Soapstone**

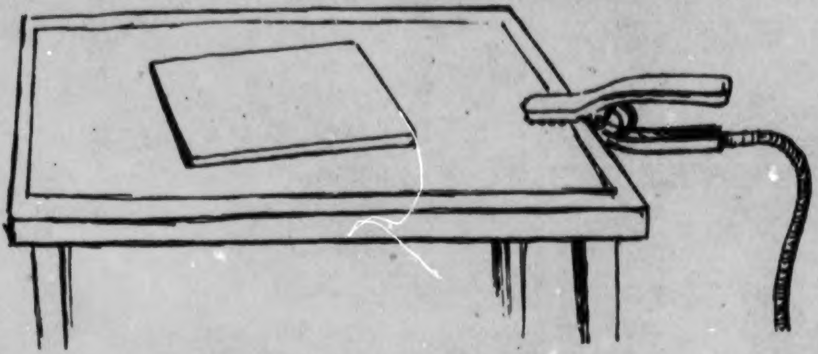
2. Wear proper safety equipment.



3. Obtain a piece of base metal 1/4"x 6"x 4". Secure it in a vise and clean with a wire brush.



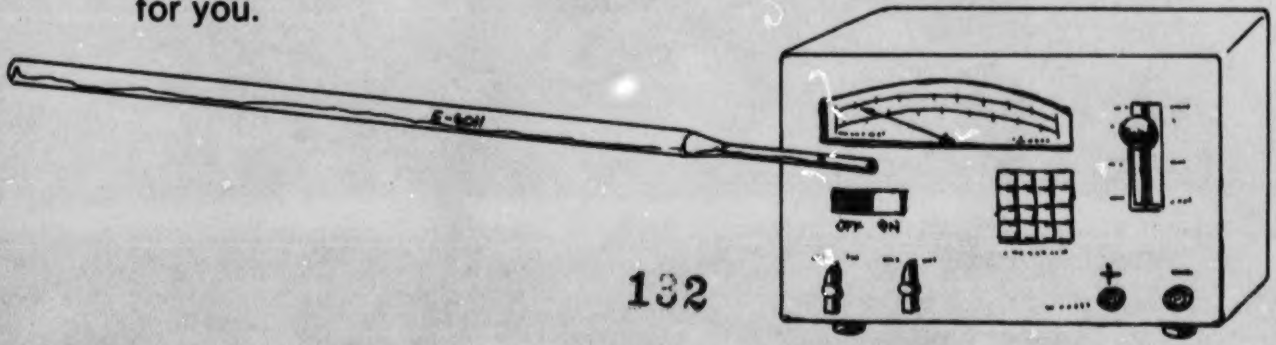
4. Position the base metal on the welding table. Attach the ground clamp securely to the welding table or base metal.



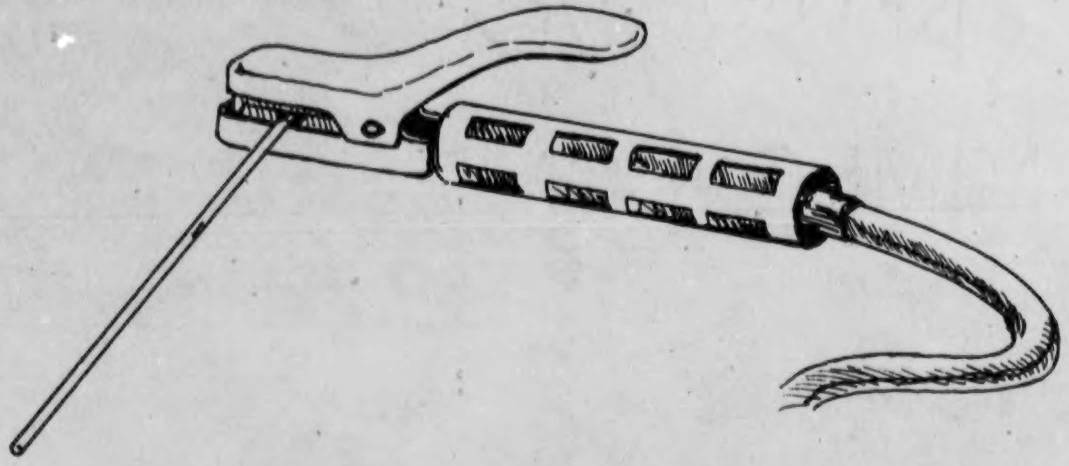
NOTE!

Attach at a spot free of paint or rust to insure a good connection.

5. Obtain a 1/8" E-6011 electrode from your instructor. Set the welding machine at 105 amperes. Your instructor may do this for you.

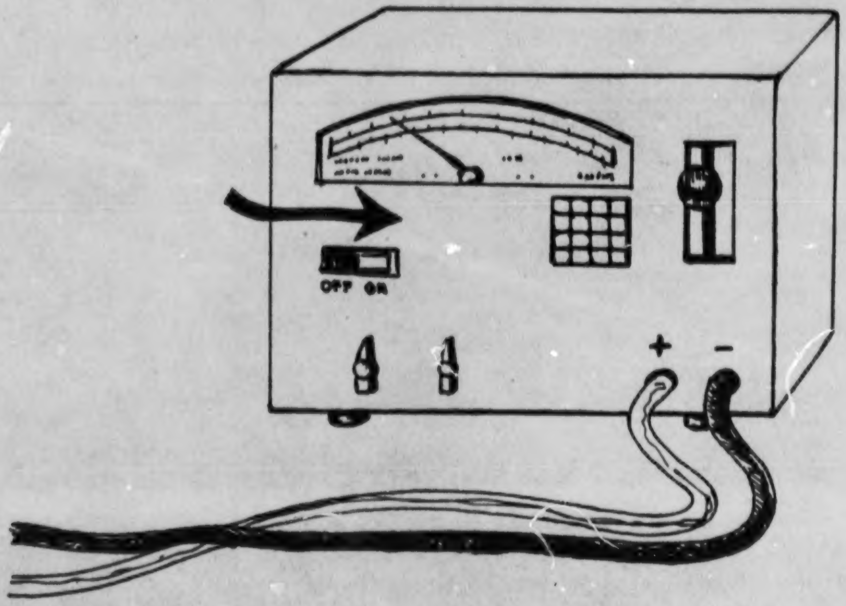


6. Insert bare end of electrode into electrode holder at a 90° angle to the jaws of the holder.

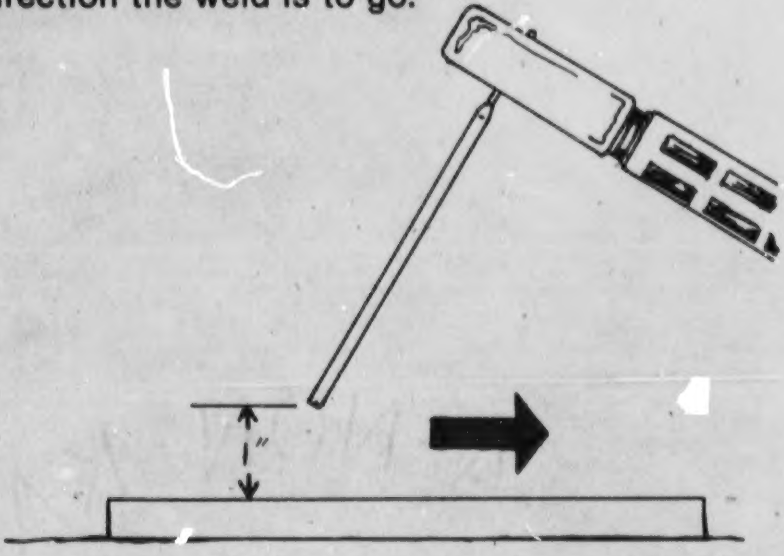


CAUTION!
Keep the electrode and holder clear of the base metal and table.

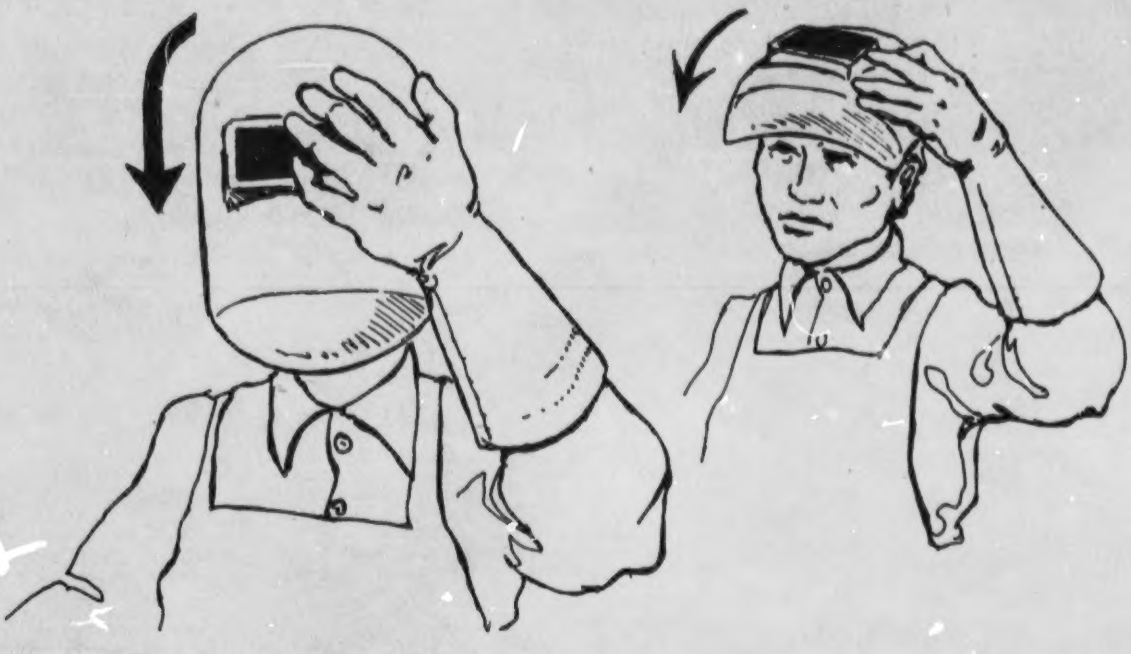
7. Switch the welding machine to the "ON" position.



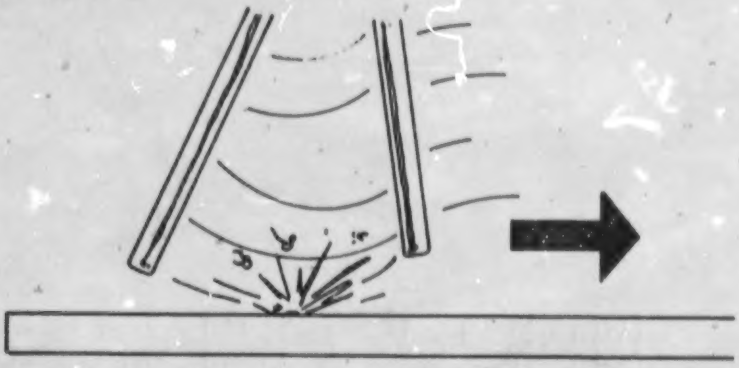
8. Hold electrode about 1" above the base metal. Slant electrode in the direction the weld is to go.



9. Lower safety helmet to cover your eyes before you start to weld.

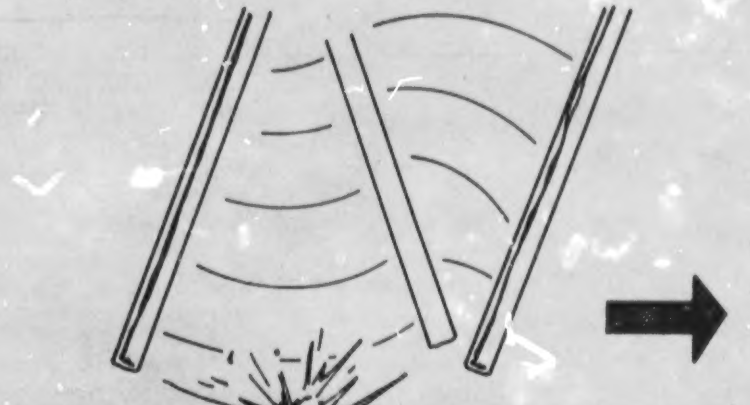


10. Quickly touch base metal with the electrode and gently drag the electrode. This motion is similar to striking a match against a surface.



The action you performed is called 'Striking an Arc'.

11. Raise electrode to about 3/16" above the base metal. This is to 'establish the arc.'



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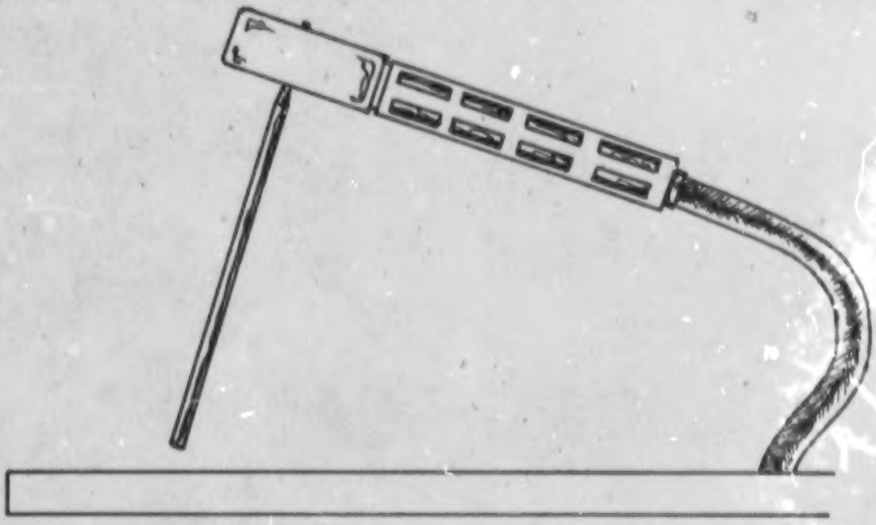
12. Lower electrode to 1/8" above the molten puddle on the base metal. This is the correct arc length to maintain while welding.

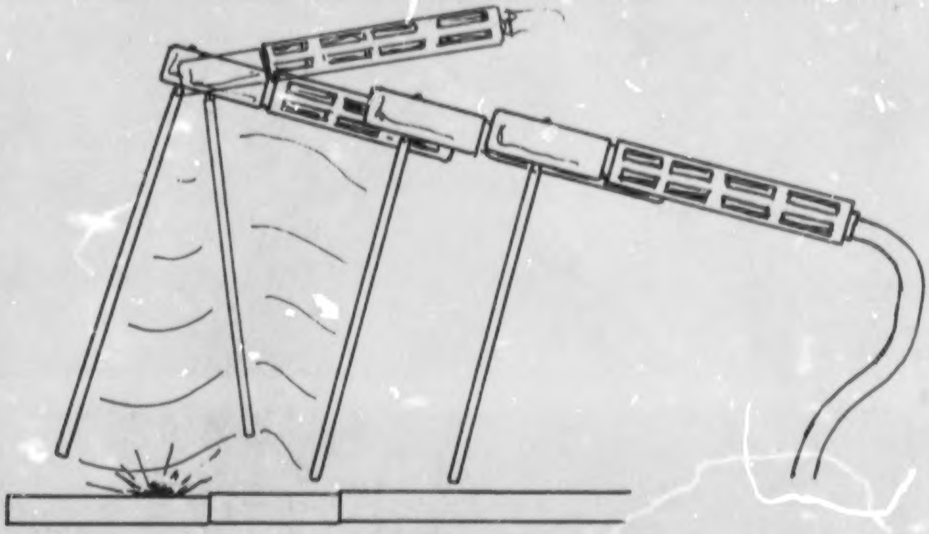


NOTE!

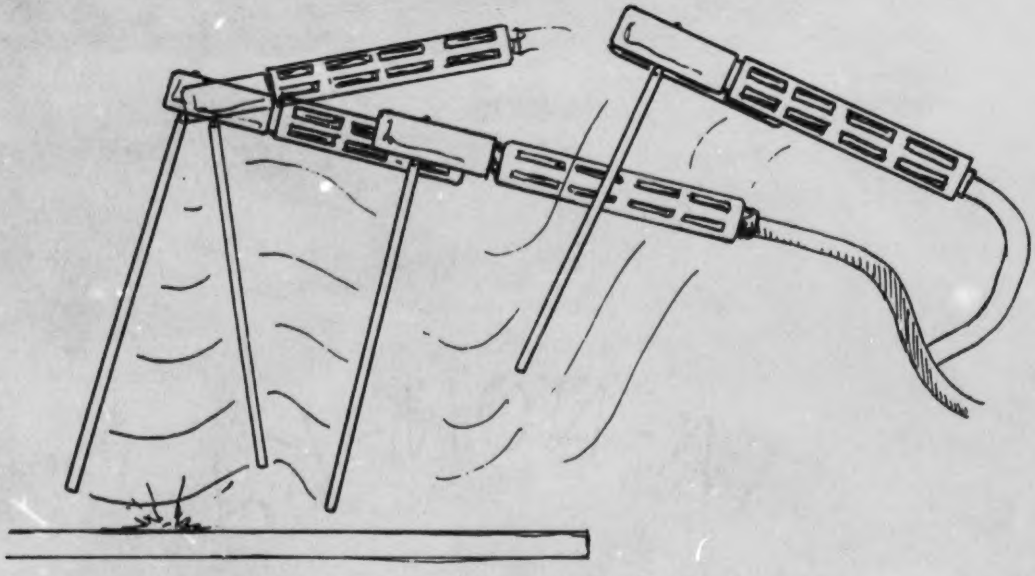
DO NOT maintain an arc length of less than 1/8" or the electrode will stick to the base metal.

If the electrode should stick, DO NOT remove your helmet until the electrode is free from either the electrode holder or the base metal.

13. Try striking an arc several times until you can control the arc.



14. To break the arc, raise the electrode quickly.



15. When finished, turn off the machine and have your instructor check your work.

16. Clean your work area and return tools to their right places.

SEE YOUR INSTRUCTOR

Unit 10
Running Short Beads with an Electrode

Tools and Materials Identification Exercise

Match the words with the correct objects provided below:

____A. Ground Clamp

____B. Welding Helmet

____C. Welding Gloves

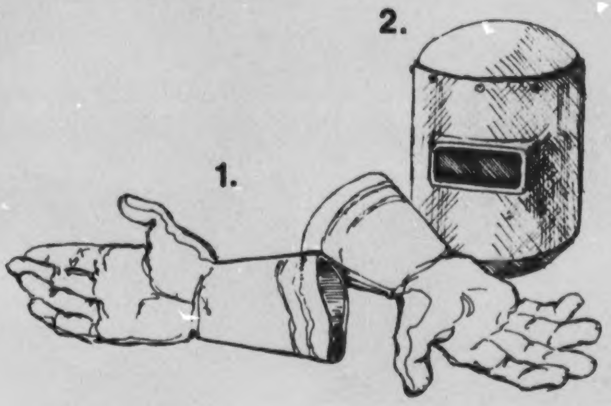
____D. Electrode Holder

____E. Chipping Hammer

____F. Electrode

2.

1.



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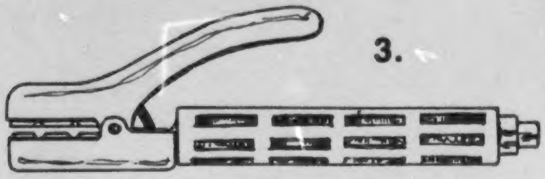

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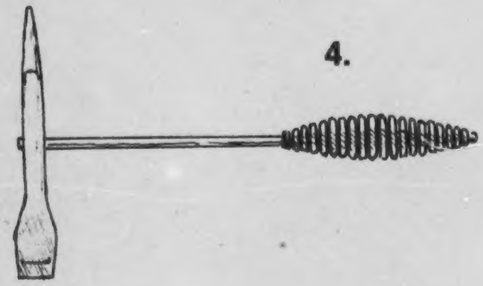

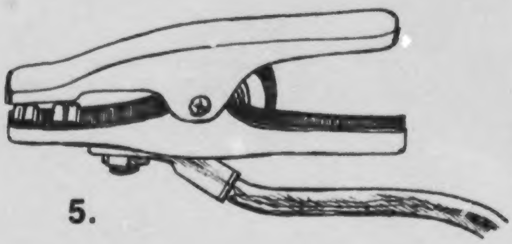

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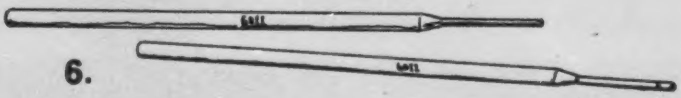

6.

Unit 10
Striking an Arc

Practical Exercise Performance Checklist

The student ______________________ successfully performed the following tasks:

	Tasks	Yes	No	Comments
1.	Identified:			
	a. Ground clamp			
	b. Welding helmet			
	c. Welding gloves			
	d. Electrode holder			
	e. Chipping hammer			
	f. Electrode			
2.	Wore proper safety equipment			
3.	Thoroughly cleaned base metal			
4.	Properly placed base metal on the welding table			
5.	Removed all flammable materials from the welding table			
6.	Attached ground clamp to welding table or base metal			
7.	Set welding machine to correct amperage and arc voltage (This step can be performed by the instructor.)			
8.	Wore welding helmet in a raised position			
9.	Correctly inserted electrode into electrode holder			
10.	Switched welding machine to "ON"			
11.	Correctly held electrode while getting ready to strike an arc			
12.	Lowered helmet to protect the eyes			

Tasks	Yes	No	Comments
13. Correctly struck an arc			
14. Maintained correct arc length			
15. Correctly broke the arc			
16. Turned off the welding machine			
17. Moved or handled hot metal safely			
18. Cleaned work area and returned tools to their right places			

Satisfactory Performance ☐
Repeat Exercise ☐
Should Move On ☐

Instructor's Signature   Date

Vocational Preparation Curriculum
WELDING

Unit 11

Running Short Beads with an Electrode

Developed by: Hogan Usoro

PRACTICAL ARTS AND VOCATIONAL-TECHNICAL EDUCATION
iml
INSTRUCTIONAL MATERIALS LABORATORY
UNIVERSITY OF MISSOURI-COLUMBIA

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Unit 11
Running Short Beads with an Electrode

Running Short Beads with an Electrode.

After you have studied this lesson, you should be able to:

1. Clean a base metal for welding.
2. Run short beads with an electrode.

Show What You Can Do.

Check the statement that fits you best.

1. ☐ **I can do all the tasks above and want my instructor to give me the Practical Exercise.**

   → **SEE YOUR INSTRUCTOR**

2. ☐ **I want to study the information in this unit before I do the Practical Exercise.**

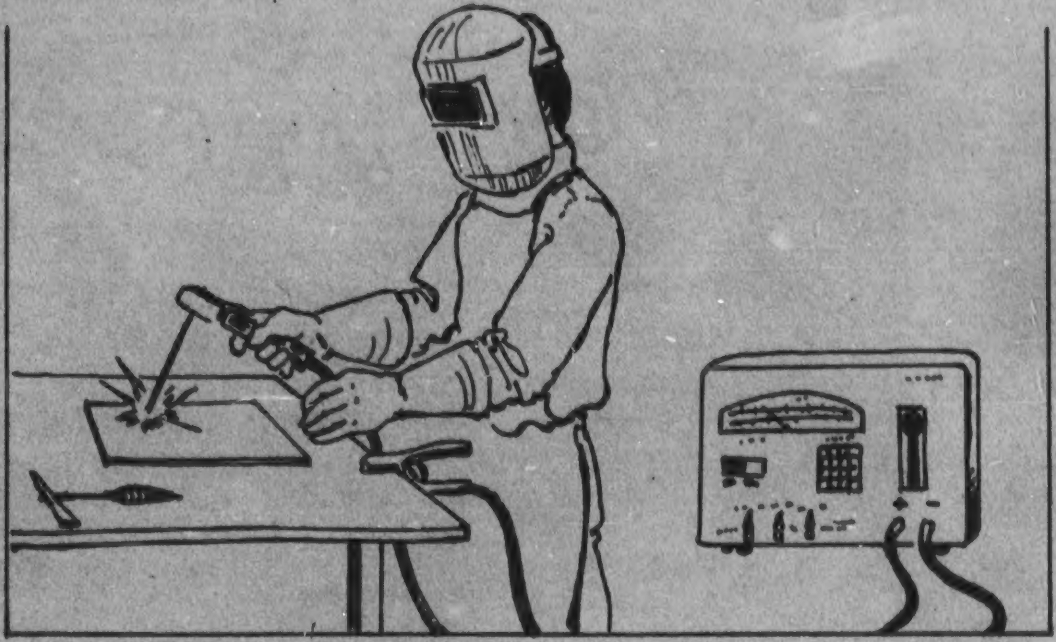
   → **TURN THE PAGE AND BEGIN**

Unit 11
Running Short Beads with an Electrode

Introduction

You have already learned how to touch an electrode to a base metal. This is called striking an arc. In this lesson, you will learn how to run short beads with the same method.

Running short beads will enable you to join metals correctly when arc welding.



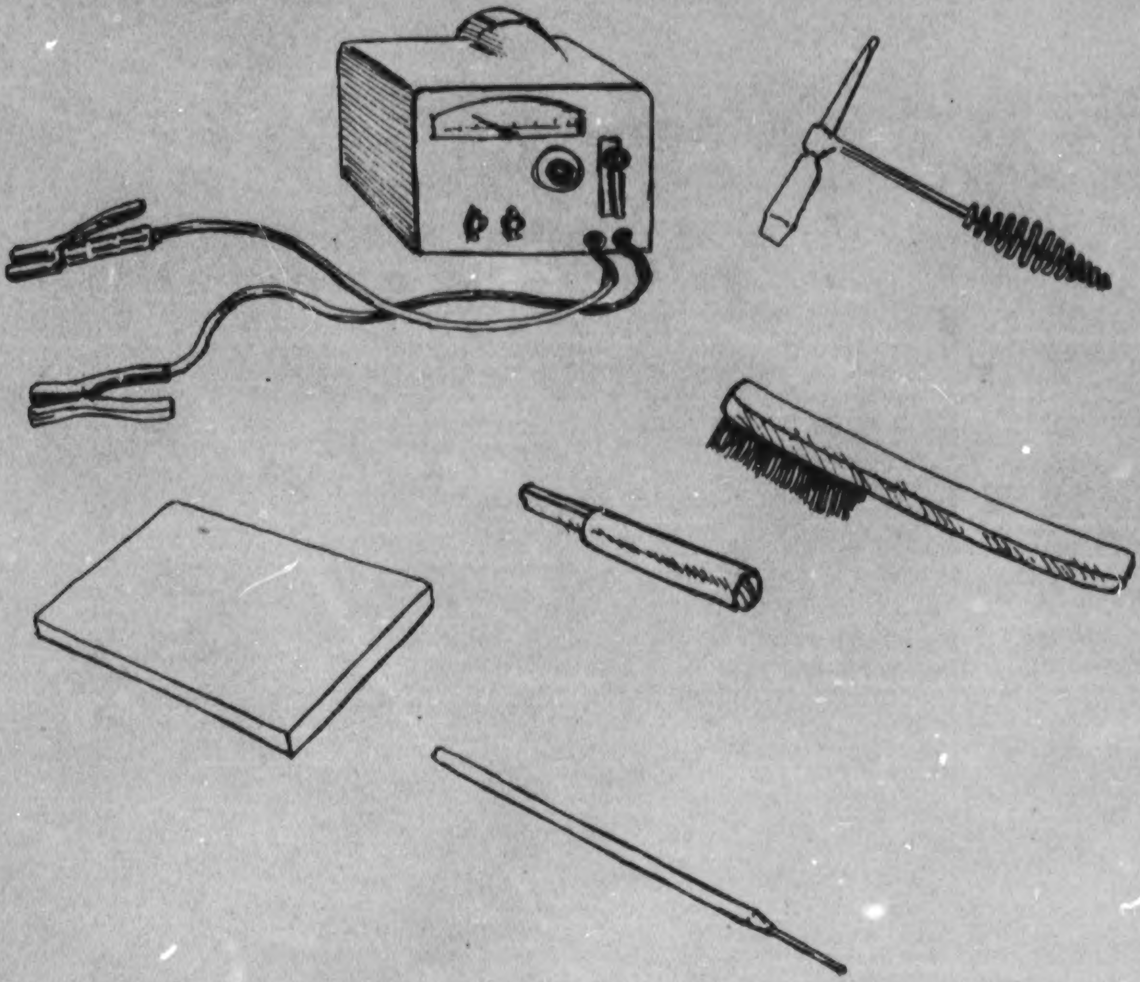
It is hoped that you will find this lesson interesting! Now let us begin.

TURN TO NEXT PAGE

Unit 11
Running Short Beads with an Electrode

A. Tools, Materials and Equipment for Running Short Beads with an Electrode.

This lesson requires same tools, materials and equipment used for striking an arc.



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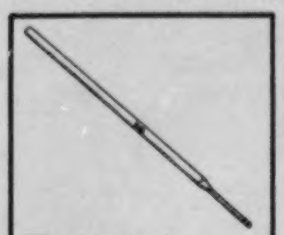
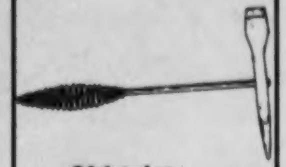
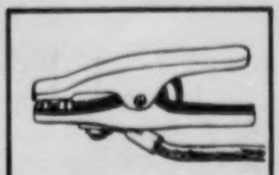
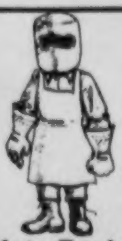
B. Steps for Running Short Beads with an Electrode.

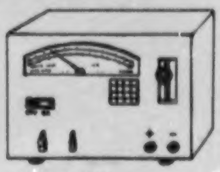
1. Find and Check Off the following:

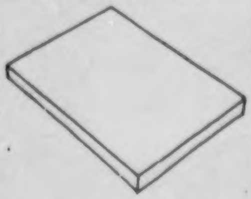

☐ **Electrode**

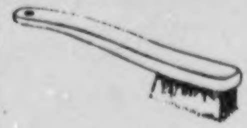

☐ **Chipping Hammer**

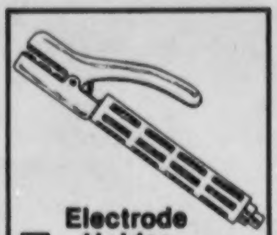

☐ **Ground Clamp**

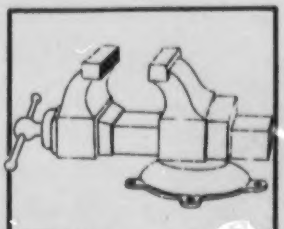

☐ **Safety Equip.**

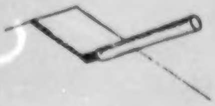

☐ **Welding Machine**


☐ **Base Metal**

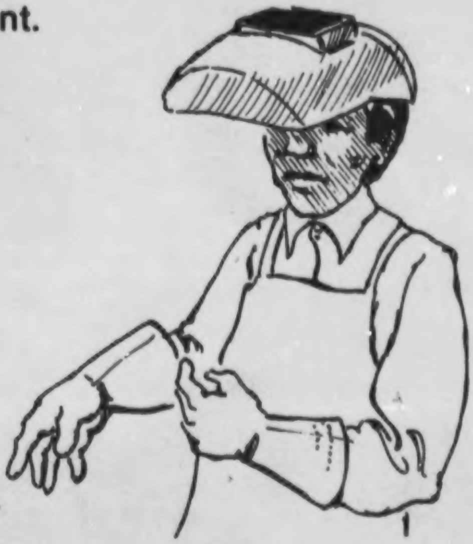

☐ **Wire Brush**


☐ **Electrode Holder**

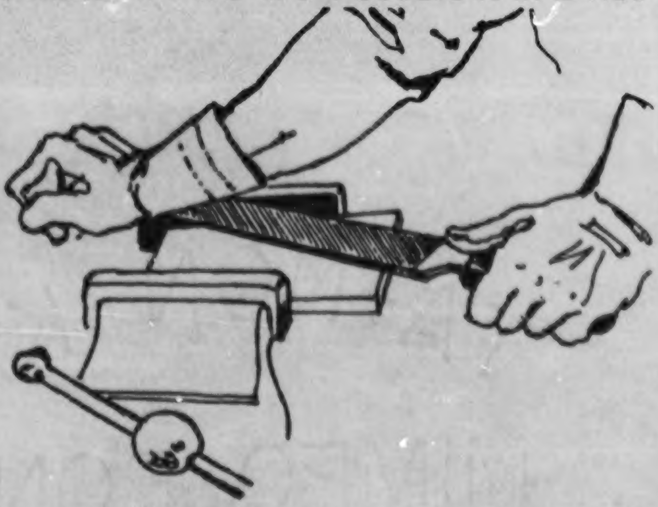

☐ **Vise**


☐ **Soapstone**

2. Wear proper safety equipment.

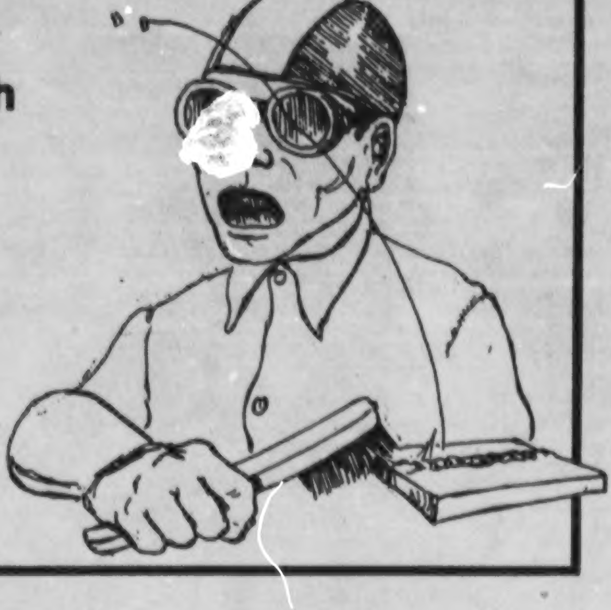


3. Obtain a base metal 1/4"x 6"x 6". Secure it in a vise and clean it.



CAUTION!

NEVER use a wire brush without wearing your safety goggles.



NOTE!

Be sure the surface of the base metal is clean, otherwise, it will not conduct the electrical current properly.

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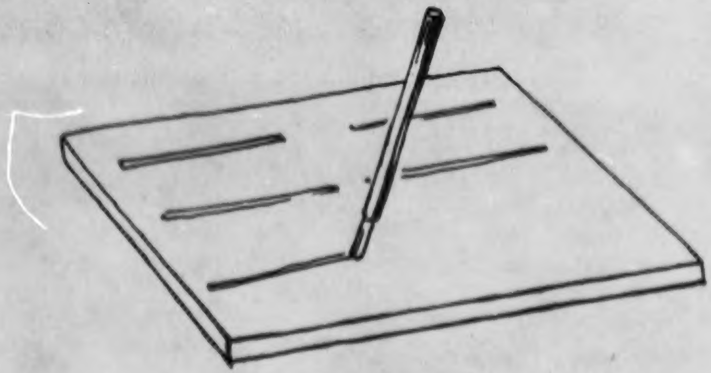
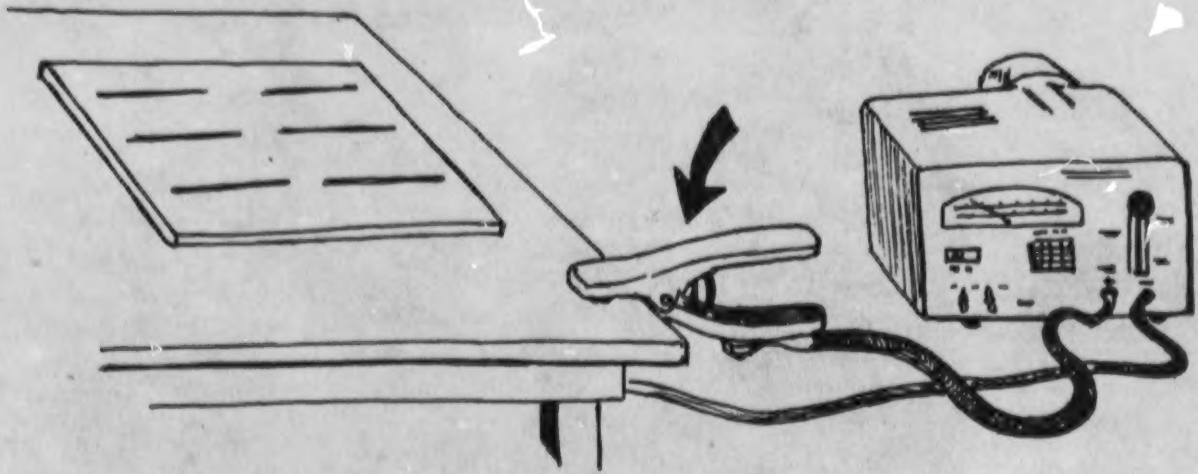
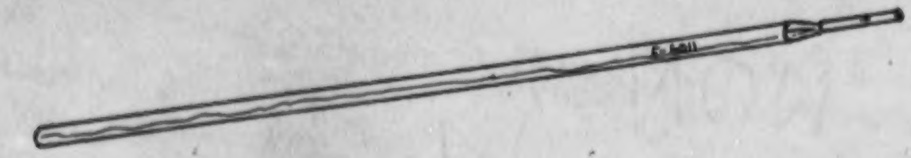
4. Draw six 2-inch lines on base metal with the soapstone marker.



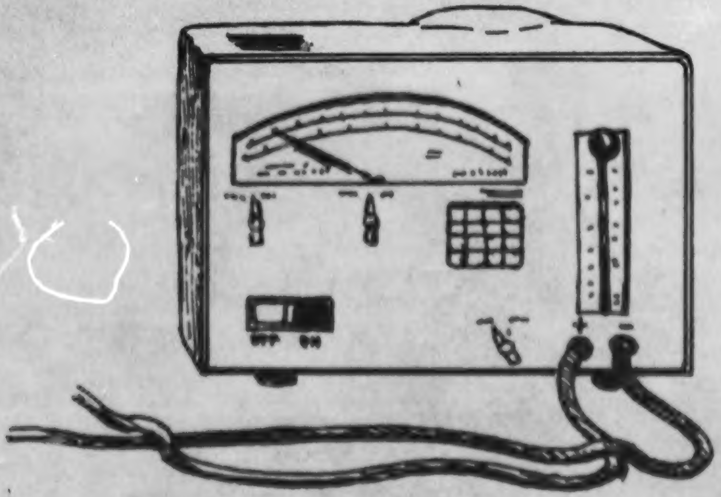
5. Place the base metal flat on welding table. Attach ground clamp to a clean spot on the welding table.



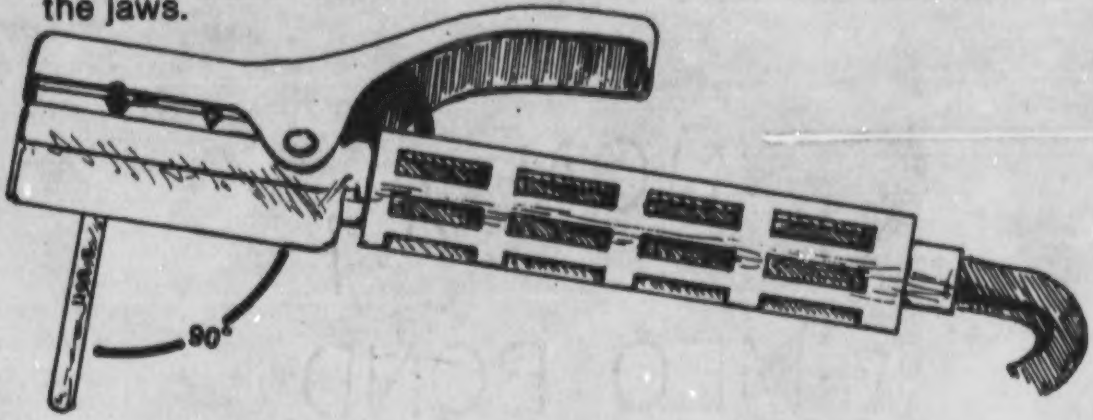
6. Obtain a 1/8" E-6011 electrode from your instructor.



7. Set welding machine at 105 amperes. Your instructor will show you how to do this.



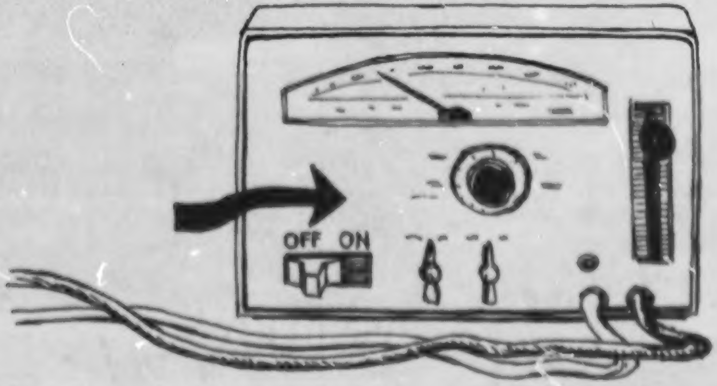
8. Insert bare end of the electrode into holder at a 90° angle to the jaws.



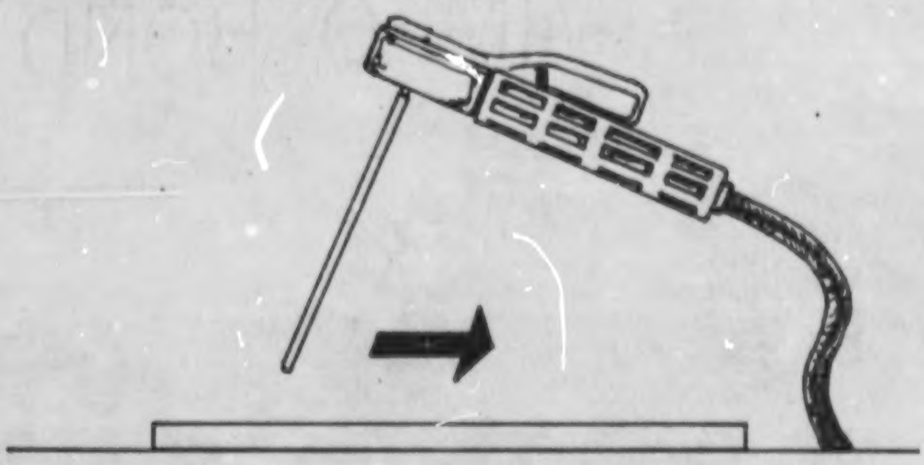
CAUTION!

Keep the electrode and holder from touching the base metal or table.

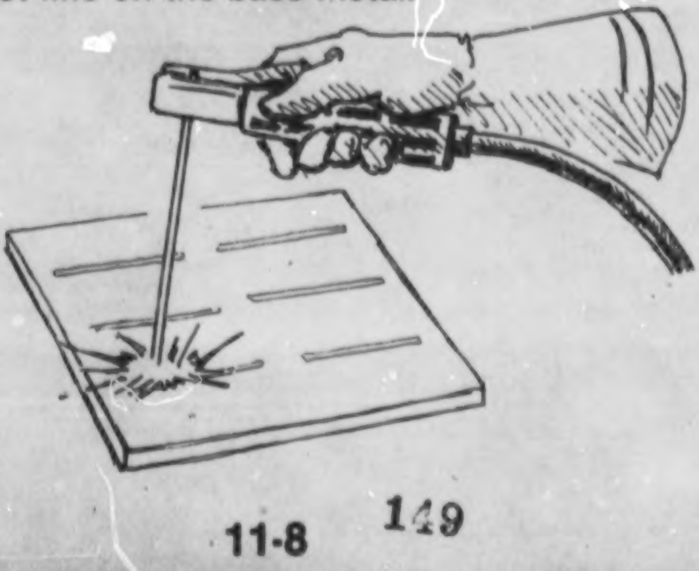
9. Switch on the welding machine.



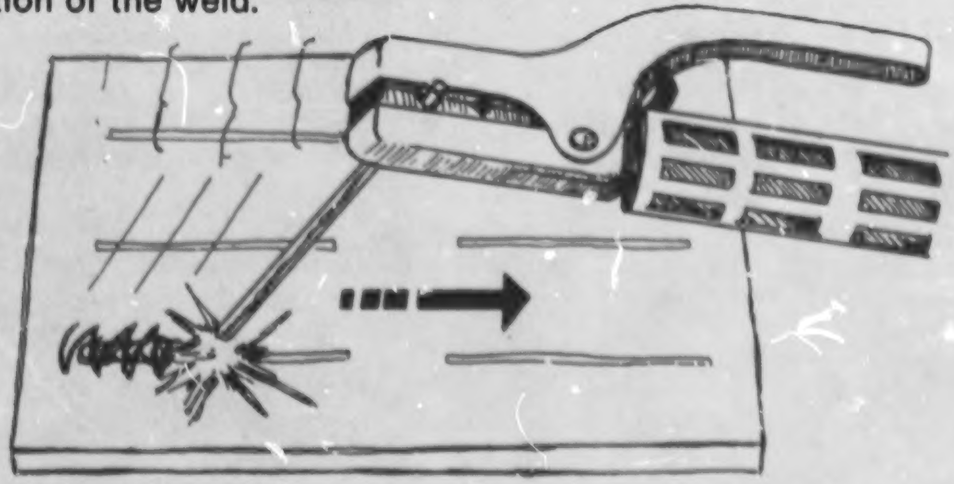
10. Hold electrode about one inch above the base metal. Slant it in the direction that you are to weld.



11. Lower your safety helmet to protect your eyes; then quickly touch the first line on the base metal.



12. Move electrode from left to right as you travel in the direction of the weld. Tilt the electrode slightly toward the direction of the weld.

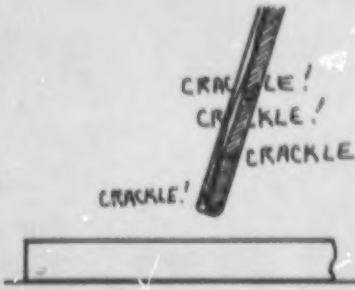


NOTE!

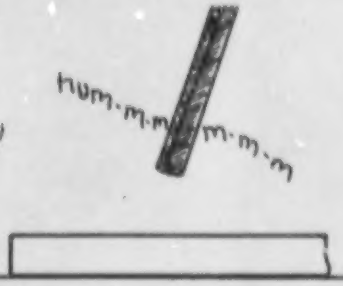
Keep the electrode moving in order to prevent it from freezing or sticking to the base metal.

Maintain correct arc length of 1/8" from the base metal surface.

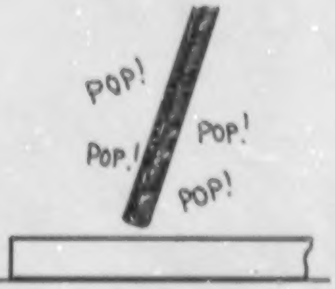
a. You hear a continuous cracking or frying noise if the welding machine is set correctly and the correct arc length is kept.
b. A humming sound (like a bee buzzing) means that the arc length is too long.
c. A popping sound means that the arc length is too short.


CRACKLE!
CRACKLE!
CRACKLE.!
CRACKLE!

Correct



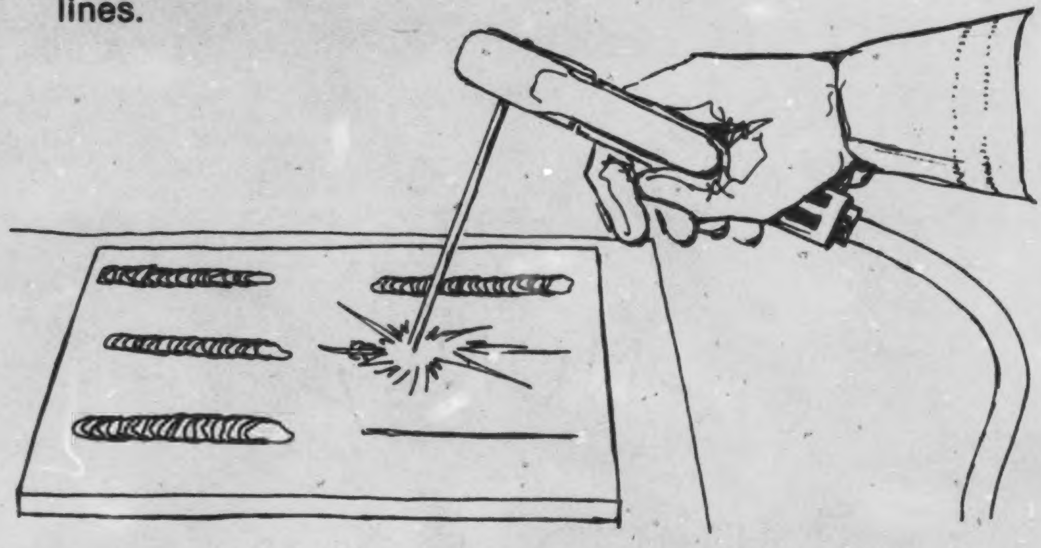
Too Long


POP!
POP!
POP!
POP!

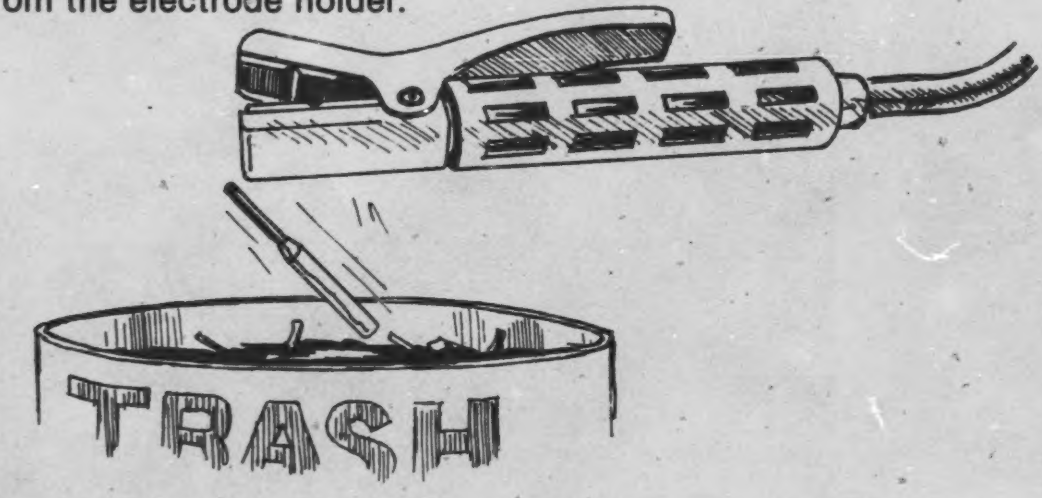
Too Short

Learn to recognize these sounds so you can do the best job possible when arc welding.

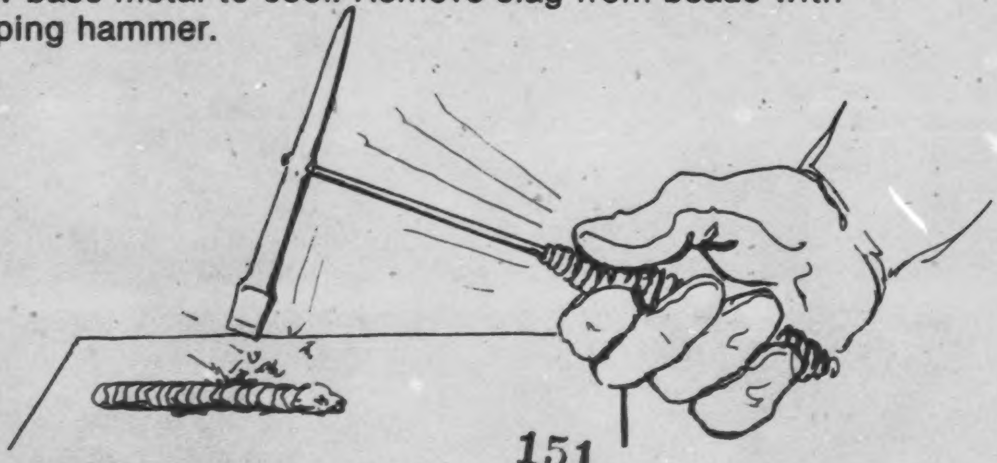
13. Practice running beads with electrode over the remaining lines.



14. When finished, switch off the machine and remove the electrode from the electrode holder.



15. Allow base metal to cool. Remove slag from beads with chipping hammer.



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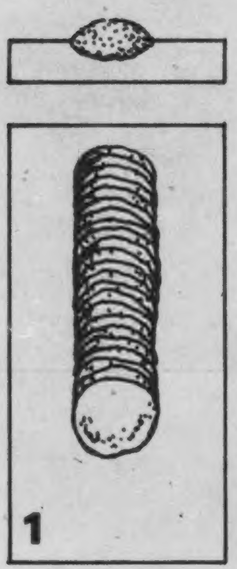
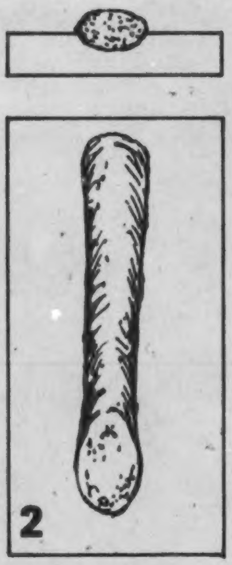
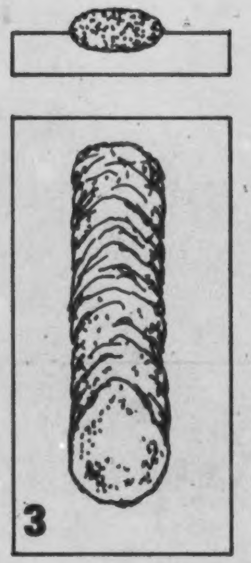
16. Compare your work with the examples below. The correct bead is number 1. Does your work look like this?



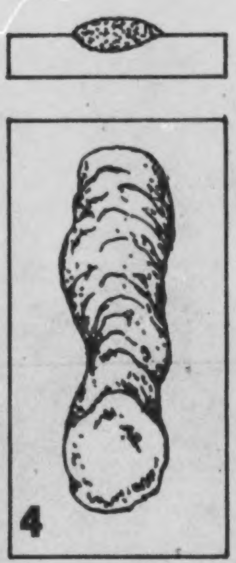
Normal Weld



Speed Too Fast



Speed Too Slow



Arc Too Long

17. Clean your work area. Put the slag and electrode stubs into slag box.

18. Return the tools to their right places.

SEE YOUR INSTRUCTOR

Unit 11
Running Short Beads with an Electrode

Practical Exercise Performance Checklist

The student ____________________ successfully performed the following tasks:

Tasks	Yes	No	Comments
1. Wore proper safety equipment			
2. Properly cleaned base metal			
3. Correctly drew soapstone lines on base metal			
4. Properly positioned base metal on the welding table			
5. Properly attached ground clamp to the table or base metal			
6. Set machine to correct amperage and arc voltage (This step can be performed by the instructor.)			
7. Wore helmet in raised position while inserting electrode into holder			
8. Kept electrode and holder clear of base metal or table			
9. Switched on welding machine			
10. Held electrode correctly in a ready position to start welding			
11. Lowered helmet to protect the eyes			
12. Laid weld beads properly along soapstone line			
13. Moved electrode from left to right and slightly tilted toward the direction of travel			
14. Maintained correct arc length			

Tasks	Yes	No	Comments
15. Completed laying beads along soapstone lines			
16. Switched off machine after welding			
17. Correctly removed electrode from holder			
18. Safely moved or handled welded metal			
19. Cleaned slag from the weld			
20. Cleaned work place and put electrode stubs and slag into slag box			
21. Returned tools to their proper places			

Satisfactory Performance ☐
Repeat Exercise ☐
Should Move On ☐

Instructor's Signature Date

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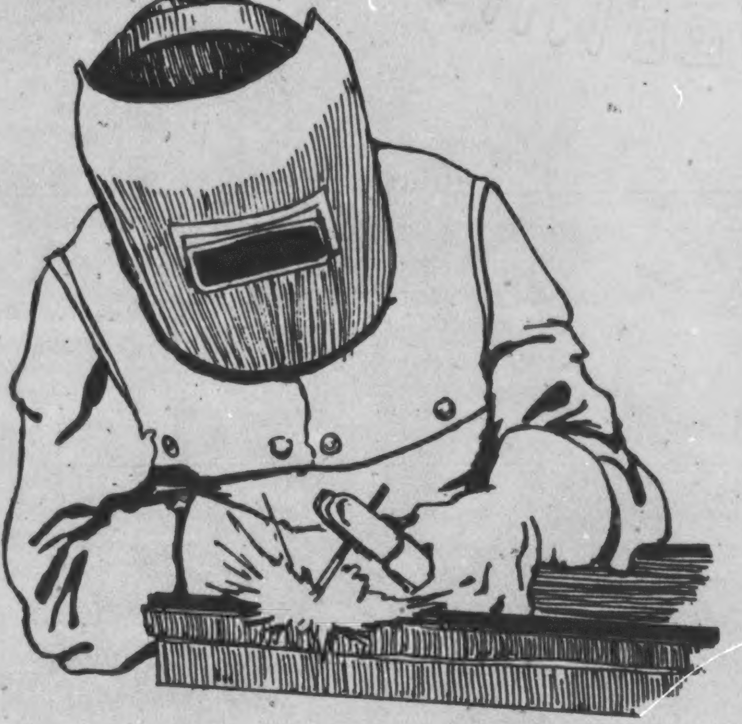
Vocational Preparation Curriculum
WELDING



Unit 12

Welding in a Flat Position with an Electrode

Developed by: Hogan Usoro

PRACTICAL ARTS
AND
VOCATIONAL-TECHNICAL
EDUCATION
iMl
INSTRUCTIONAL MATERIALS LABORATORY
UNIVERSITY OF MISSOURI-COLUMBIA

Unit 12
Welding in a Flat Position with an Electrode

Welding in a Flat Position with an Electrode

After you have studied this lesson, you should be able to:

1. Clean metal joints to be welded in a flat position.
2. Weld metal joints in a flat position with an electrode.

Show What You Can Do.

Check the statement that fits you best.

1. ☐ **I can do all the tasks above and want my instructor to give me the Practical Exercise.**

SEE YOUR INSTRUCTOR

2. ☐ **I want to study the information in this unit before I do the Practical Exercise.**

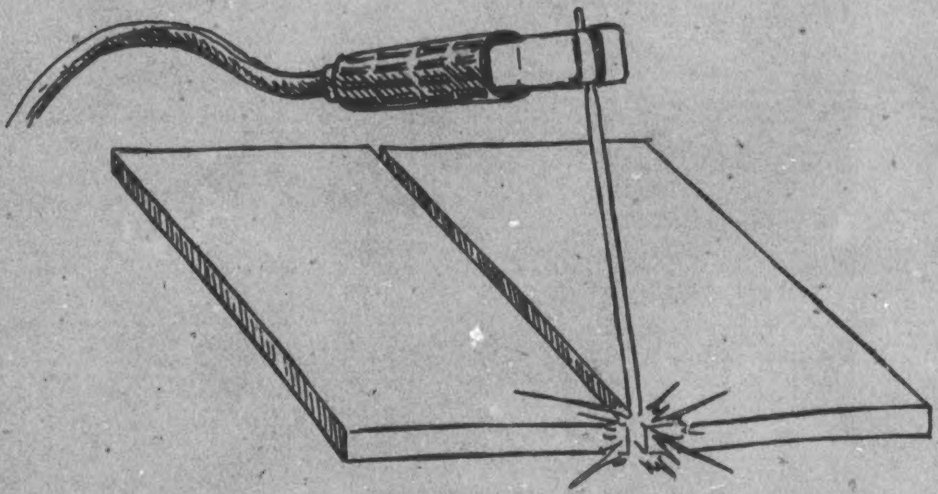
TURN THE PAGE AND BEGIN

Unit 12
Welding in a Flat Position with an Electrode

Introduction

You have learned how to strike an arc and run beads with an electrode. The base metals you used were placed flat on the welding table. In this lesson, you will use the same arc welding methods to weld a metal joint in a flat position. The joint you are going to weld is called a butt joint.

A butt joint is formed by metals placed edge to edge. The butt joint is used to join metal pieces that have flat surfaces. It is used to build tanks, boilers and similar containers.



It is hoped that you will find this lesson exciting! Now, let us begin.

TURN TO NEXT PAGE

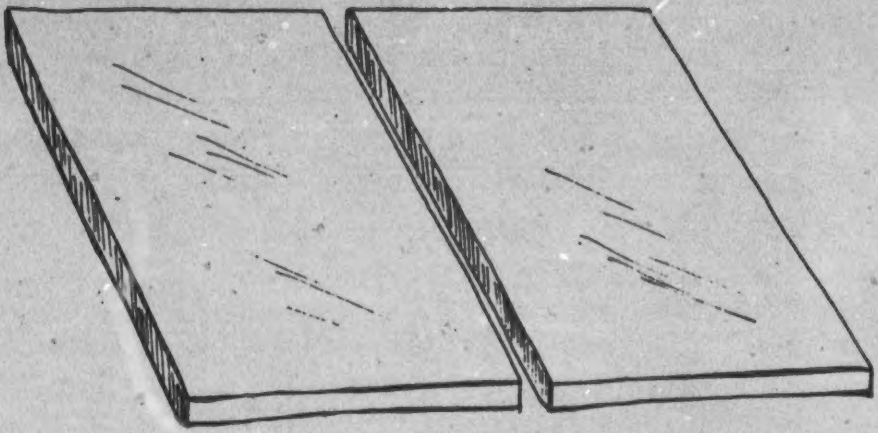
Unit 12
Welding in a Flat Position with an Electrode

A. Tools, Materials and Equipment for Welding in a Flat Position with an Electrode

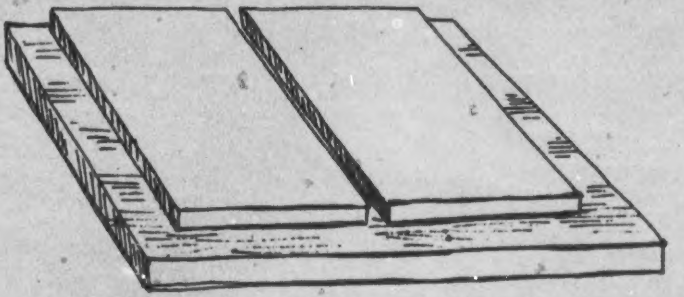
1. This lesson requires the same tools as the ones you have used before.

2. The new materials needed are:

   a. Two pieces of base metals, each 1/4"x 4"x 6".



   b. A back-up copper block to support the base metals .



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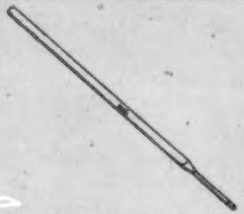
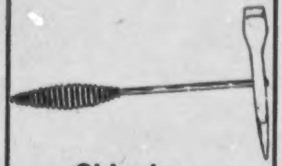
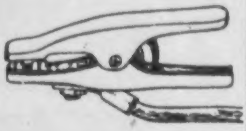
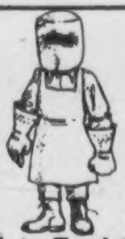
B. Steps for Welding in a Flat Position with an Electrode.

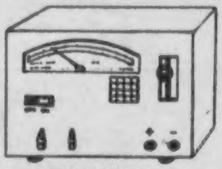
1. Find and Check Off the following:

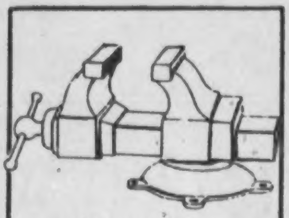

☐ **Electrode**

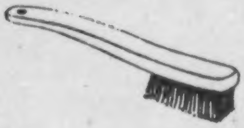

☐ **Chipping Hammer**

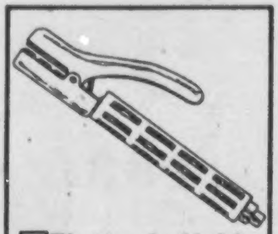

☐ **Ground Clamp**

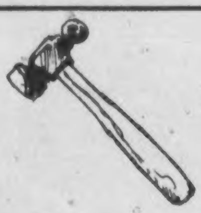

☐ **Safety Equip.**

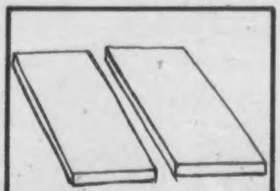

☐ **Welding Machine**

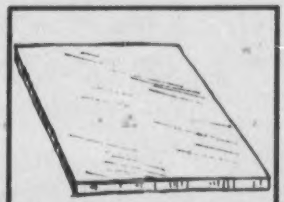

☐ **Vise**

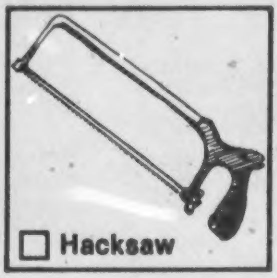

☐ **Wire Brush**


☐ **Electrode Holder**

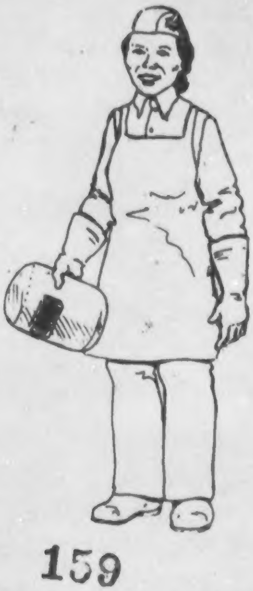

☐ **Hammer**


☐ **Base Metals**

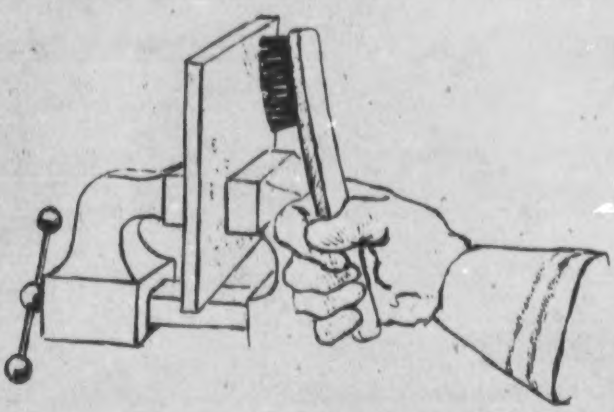

☐ **Back-Up Block**


☐ **Hacksaw**

2. Wear proper safety equipment.



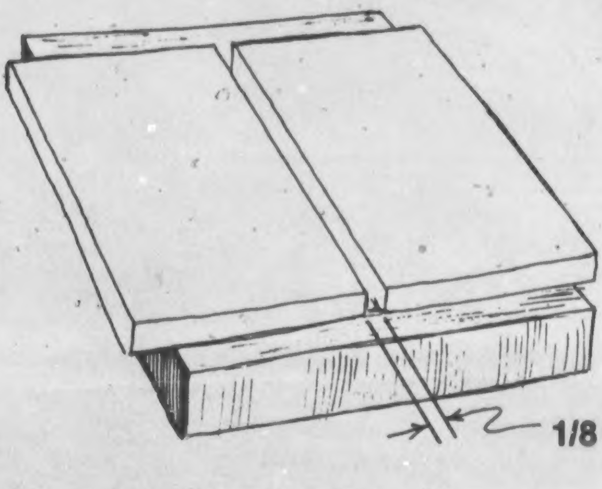
3. Obtain two pieces of mild steel, each 1/4"x 4"x 6" and clean them thoroughly with a wire brush. Also obtain a back-up block.



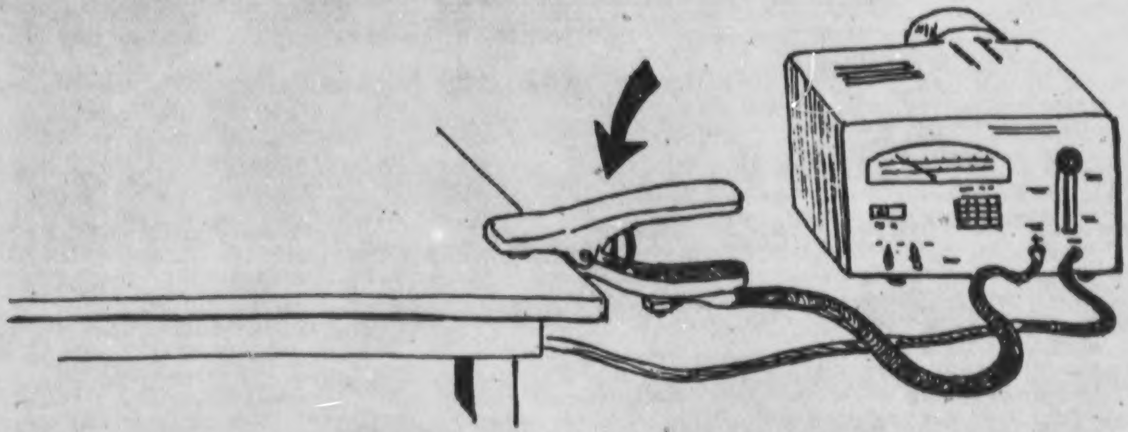
CAUTION!

NEVER use a wire brush without wearing your safety goggles.

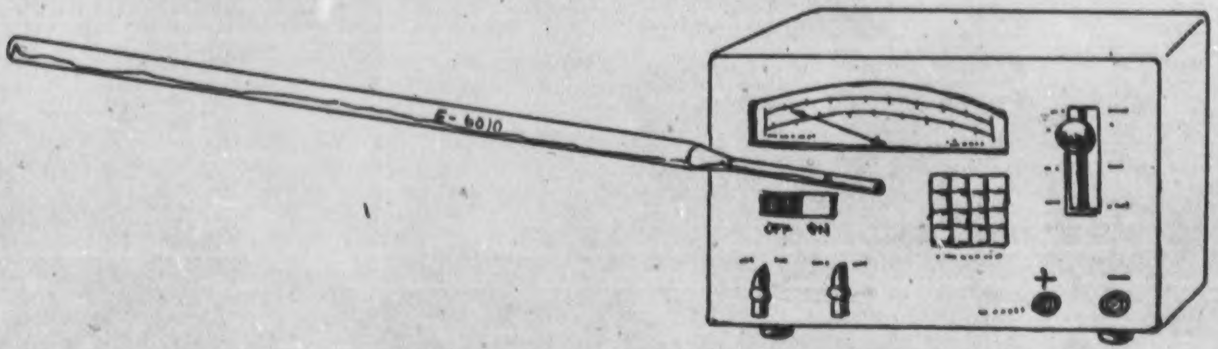
4. Place the two pieces of metal in position for welding.



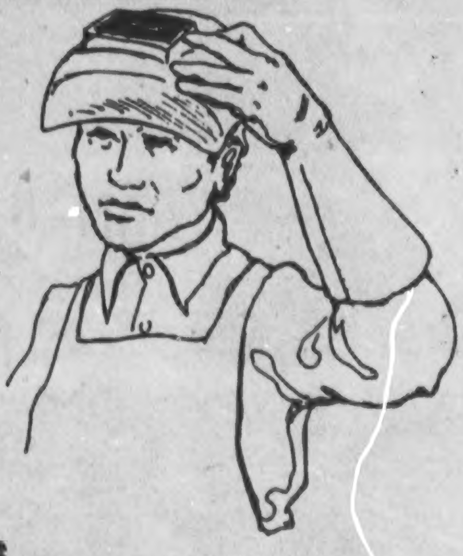
5. Attach the ground clamp to the welding table at a clean spot.



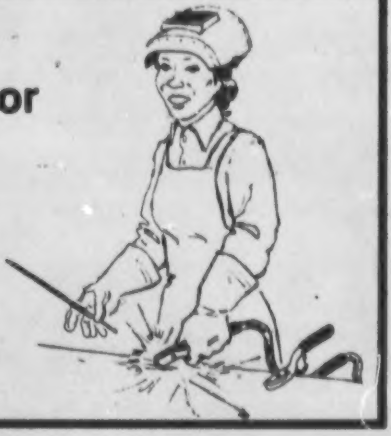
6. Obtain a 5/32" E-6010 electrode. Set the welder to 140 amperes of current. Your teacher will show you how to do this.



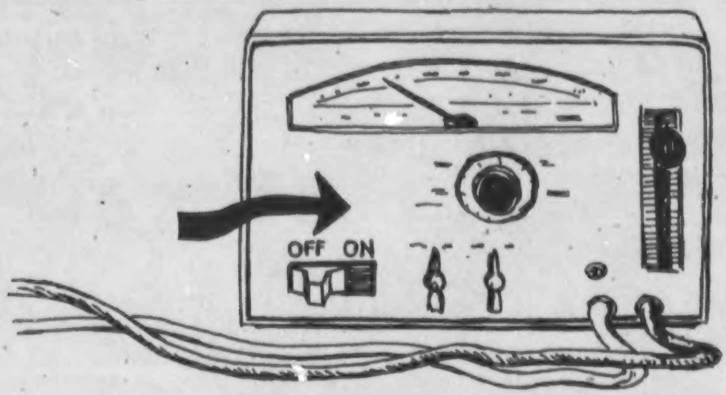
7. Put on your welding helmet in a raised position. Then insert the bare end of the electrode into the holder.



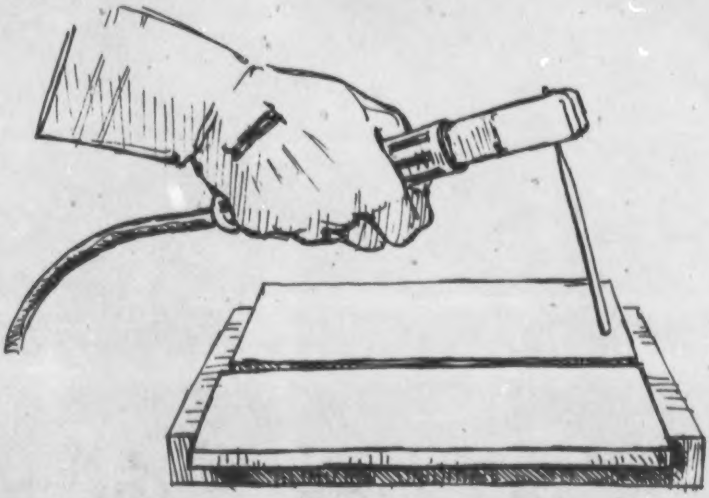
CAUTION!
Keep the electrode and holder from touching the base metal or table.



8. Switch on the welder.

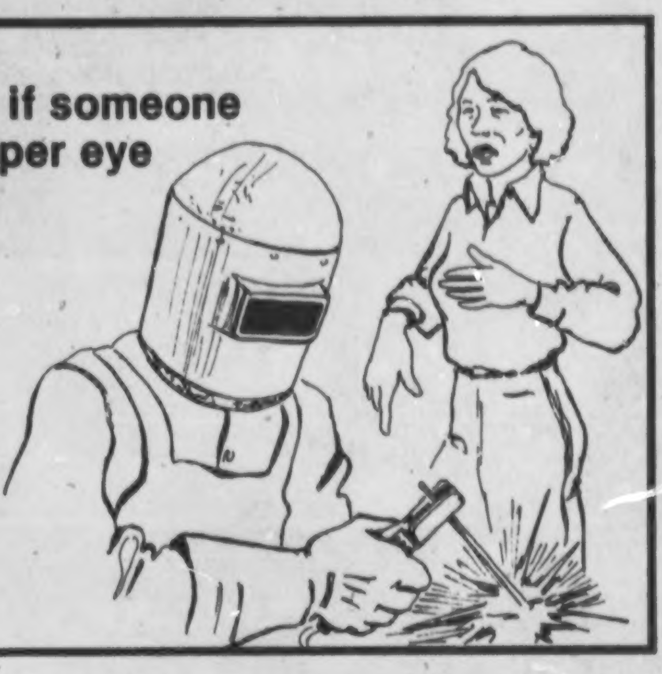


9. Hold the electrode about one inch above the end of the butt joint. Lower the helmet over your eyes and tack weld both ends of the joint.

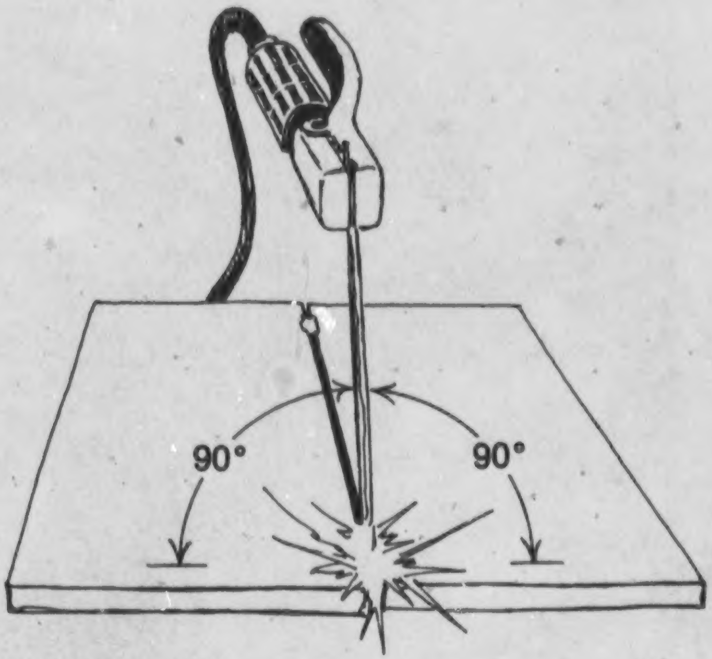


CAUTION!

DO NOT strike an arc if someone is nearby without proper eye protection.



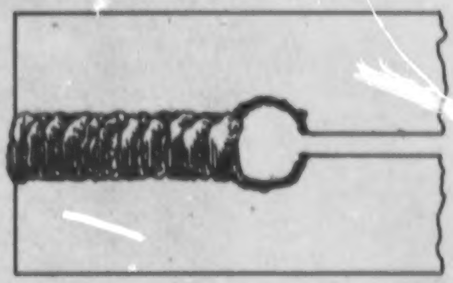
10. Keep the side angles of the electrode straight when you begin welding.



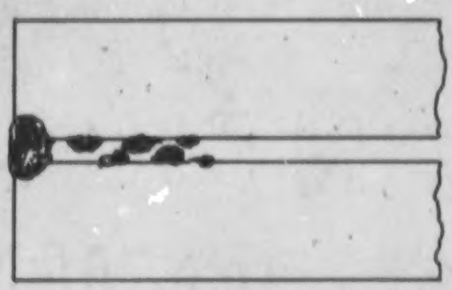
11. Lower the electrode as it melts away so that the arc length will stay the same.

NOTE!

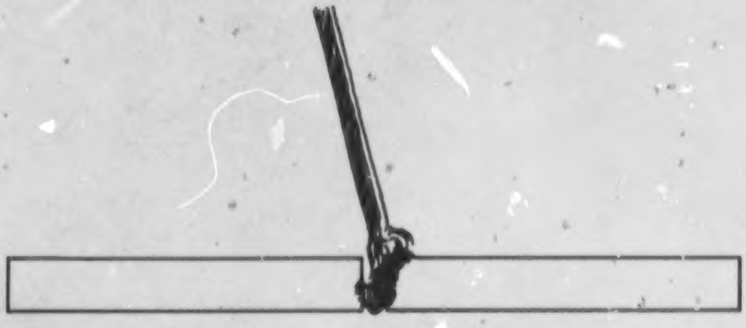
DO NOT move the electrode too slowly, otherwise you will burn a hole through the metals.



DO NOT move the electrode too fast, otherwise you produce a poorly fused joint between the pieces of metal.



DO NOT lean the electrode toward one piece of metal, otherwise the weld will not penetrate or build-up evenly.



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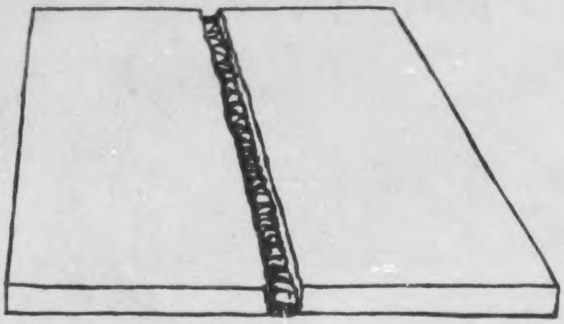
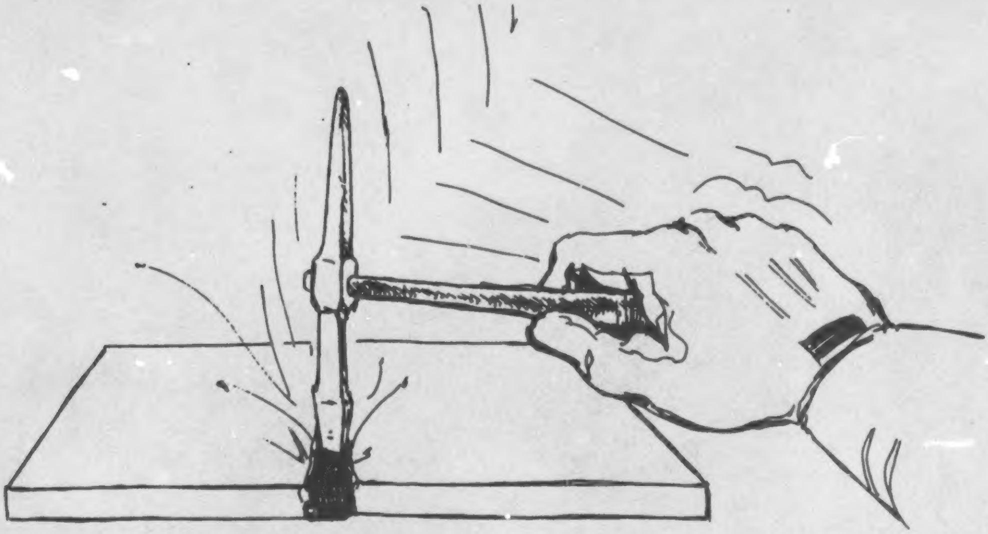
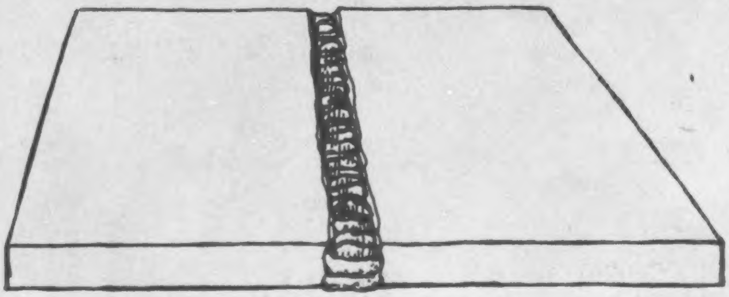
12. Lay the first layer of beads along the entire joint.



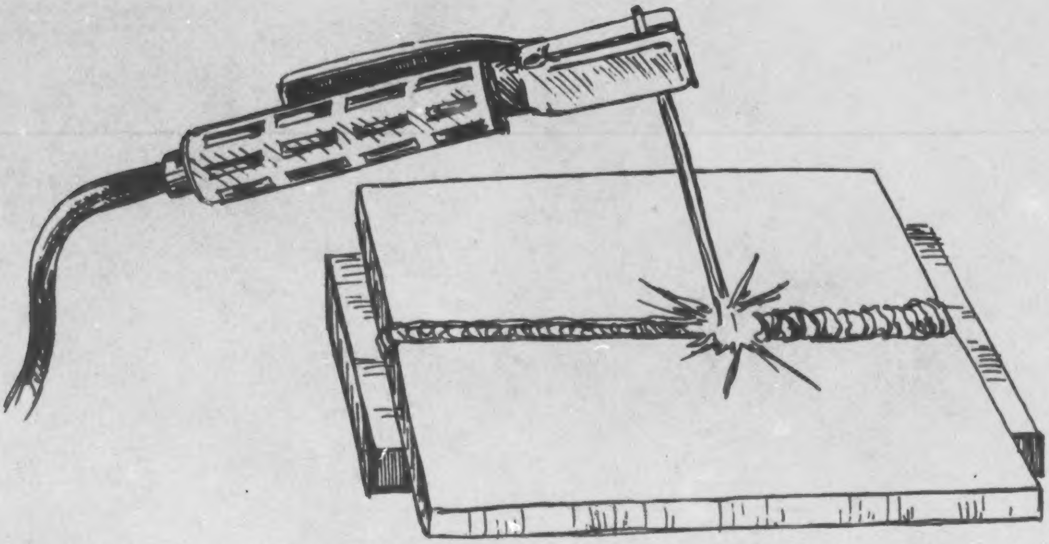
13. With the chipping hammer and wire brush, clean the first layer of beads.



14. Lay a second layer of beads; then clean it in the same manner.



15. Lay the third layer of beads in a weaving motion until the weld builds up slightly above the metal surface.

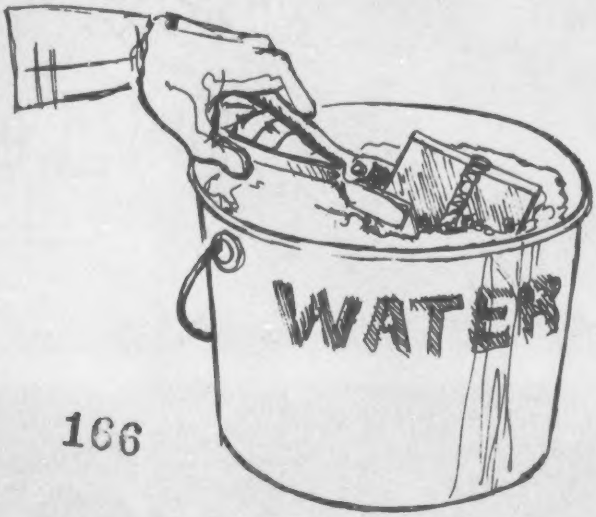


NOTE!

To make a stronger butt joint, turn over the metal and lay beads along the underside of the joint.

16. Switch off the welder after you have completed welding the joint.

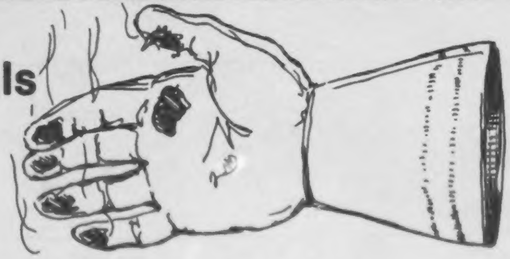
17. Cool the welded joint in a bucket of water.



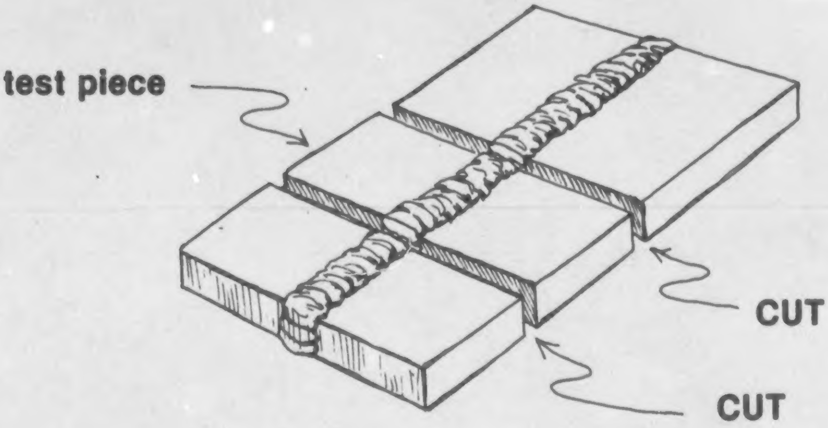
CAUTION!

DO NOT handle hot metals with your hands.

Use pliers or tongs.

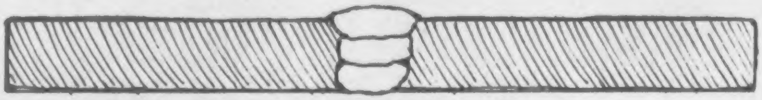


18. Secure the cooled welded joint in a vise and cut it with a hacksaw to obtain a test piece.



NOTE!

Examine how deep the weld has penetrated the joint.



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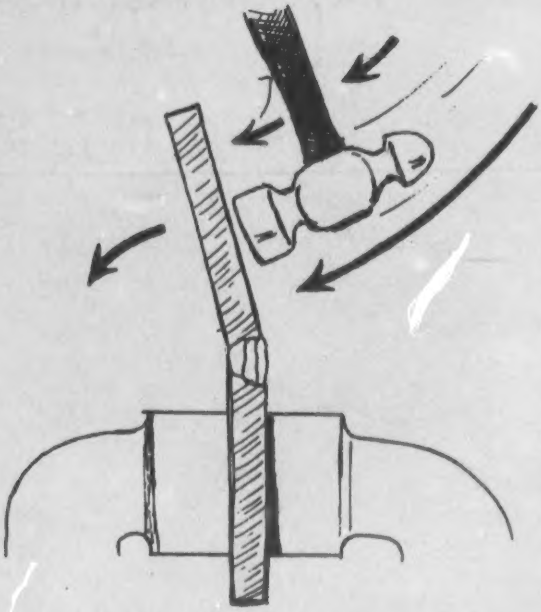
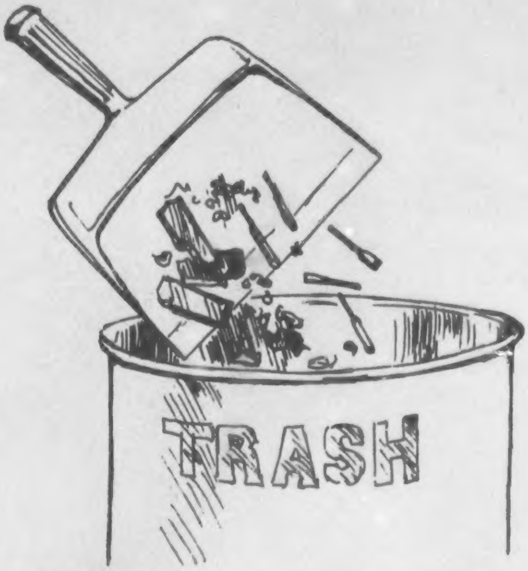
19. Secure the test piece in a vise and hit with a hammer until it breaks or flattens out.



20. Clean up your work area and put the electrode stubs, slags and waste metal pieces into the scrap box.



21. Return tools to their proper places.

SEE YOUR INSTRUCTOR

Unit 12
Welding in a Flat Position with an Electrode

Practical Exercise Performance Checklist

The student ____________________ successfully performed the following tasks:

Tasks	Yes	No	Comments
1. Wore proper safety equipment			
2. Properly and safely cleaned the base metals			
3. Correctly positioned the base metals on the welding table to weld.			
4. Properly attached the ground clamp to the welding table			
5. Obtained the proper electrode and correctly set the amperage on the welder			
6. Correctly inserted the electrode into the electrode holder			
7. Held the electrode holder safely while switching on the welder			
8. Correctly held electrode above the butt joint			
9. Kept the side angles of the electrode straight when starting to weld			
10. Lowered the electrode as it melted away into the joint			
11. Deposited the beads at a normal speed			
12. Laid the first layer of beads along the entire joint			
13. Chipped and wire brushed the first layer of beads before depositing a second layer of beads			

Tasks	Yes	No	Comments
14. Chipped and wire brushed the second layer of beads before laying the third			
15. Welded the reverse side of the joint for better penetration (optional)			
16. Switched off the welder			
17. Safely held and cooled the welded joint in a bucket of water			
18. Correctly and safely cut the welded joint to obtain a test piece			
19. Tested the strength of the weld with a vise and hammer			
20. Properly cleaned the work area and returned tools to their proper places.			

Satisfactory Performance ☐
Repeat Exercise ☐
Should Move On ☐

Instructor's Name ____________ Date ______

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Vocational Preparation Curriculum
WELDING

Unit 13

Welding a Beveled Butt Joint with an Electrode

Developed by: Hogan Usoro

PRACTICAL ARTS
AND
VOCATIONAL-TECHNICAL
EDUCATION
iml
INSTRUCTIONAL MATERIALS LABORATORY
UNIVERSITY OF MISSOURI-COLUMBIA

Unit 13
Welding a Beveled Butt Joint with an Electrode

Welding a Beveled Butt Joint with an Electrode

After you have studied this lesson, you should be able to:

1. Clean the metal joints for welding.
2. Weld a beveled butt joint.

Show What You Can Do.

Check the statement that fits you best.

1. ☐ **I can do all the tasks above and want my instructor to give me the Practical Exercise.**

SEE YOUR INSTRUCTOR

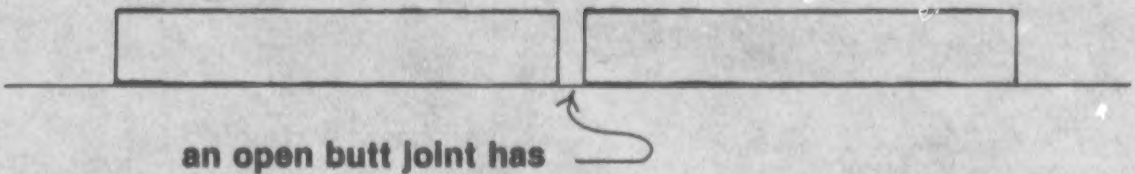
2 ☐ **I want to study the information in this unit before I do the Practical Exercise.**

TURN THE PAGE AND BEGIN

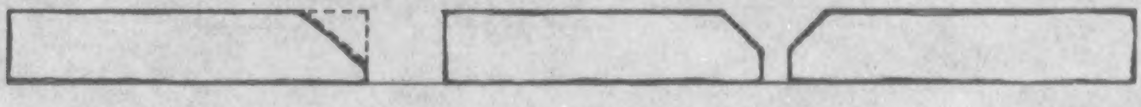
Unit 13
Welding a Beveled Butt Joint with an Electrode

Introduction

You have learned how to weld an open butt joint with straight or square edges.


an open butt joint has
straight or square sides

In this lesson, you are going to weld two pieces of metal whose edges have been cut into a bevel. You can arrange the bevels into a V-shaped joint to allow more surface for welding.



It is hoped that you will find this lesson interesting. Now let us begin.

TURN TO NEXT PAGE

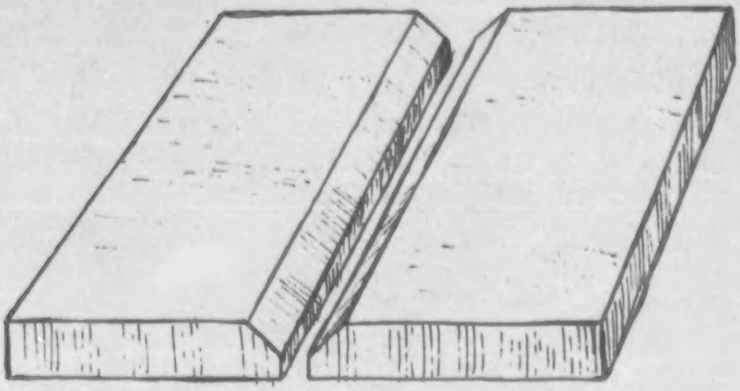
Unit 13

Welding a Beveled Butt Joint with an Electrode

A. Tools, Materials and Equipment for Welding a Beveled Butt Joint with an Electrode

1. This lesson requires the same tools and materials as in the previous lesson.

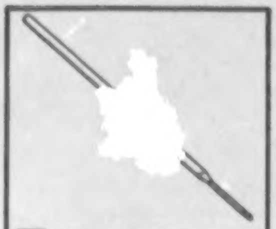
2. The new materials needed are two pieces of base metal with beveled edges.

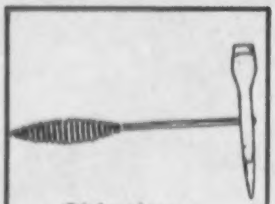


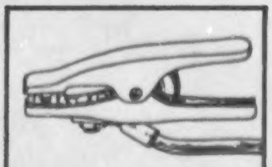
TURN TO NEXT PAGE

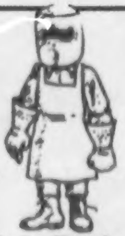
B. Steps for Welding a Beveled Butt Joint with an Electrode

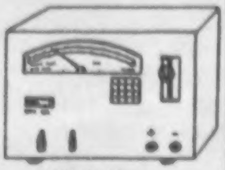
1. Find and Check Off the following:

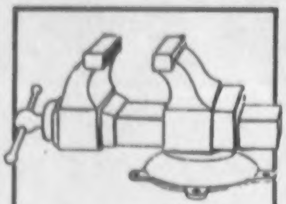

☐ Electrode

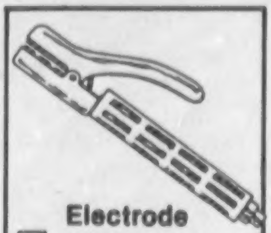

☐ Chipping Hammer

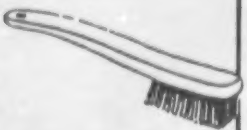

☐ Ground Clamp

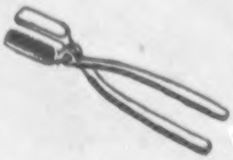

☐ Safety Equip.

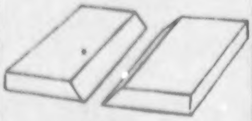

☐ Welding Machine

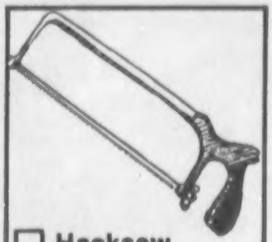

☐ Vice

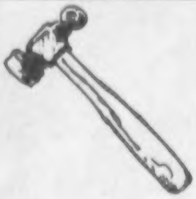

☐ Electrode Holder


☐ Wire Brush

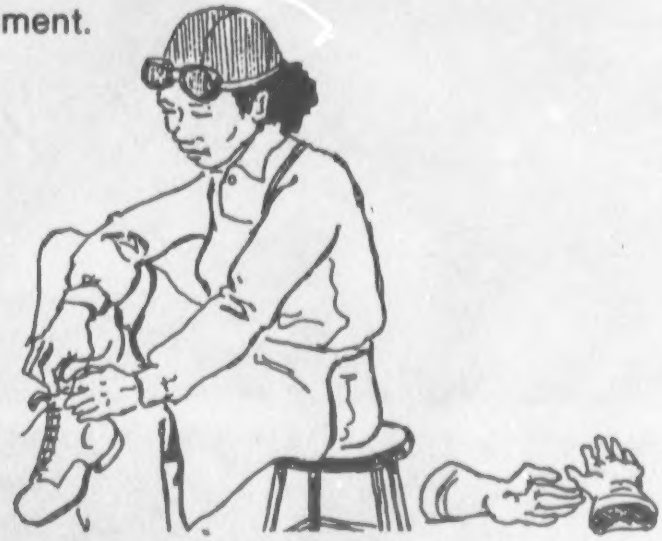

☐ Pliers


☐ Base Metals

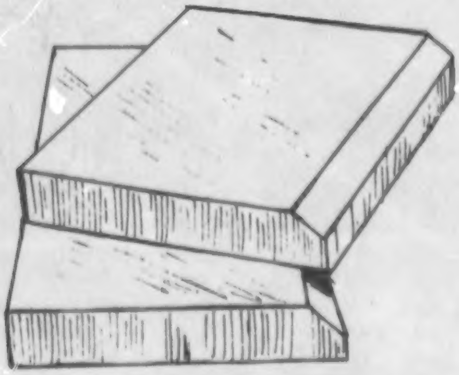

☐ Hacksaw


☐ Hammer

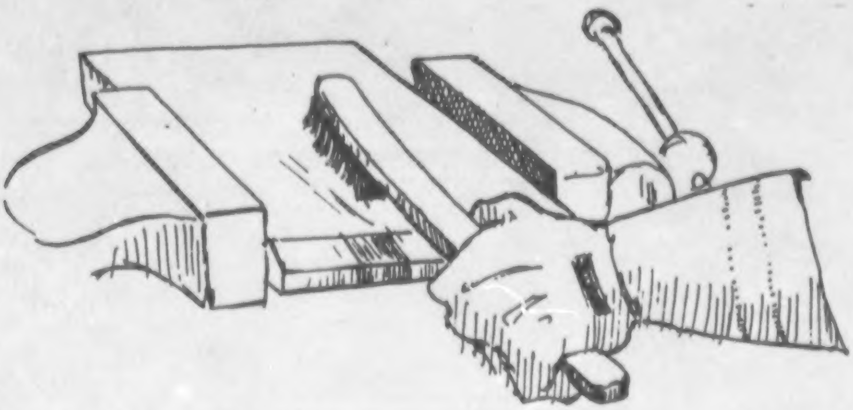
2. Wear proper safety equipment.



3. Obtain two 1/4"x 4"x 6"pieces of mild steel base metal with beveled edges.

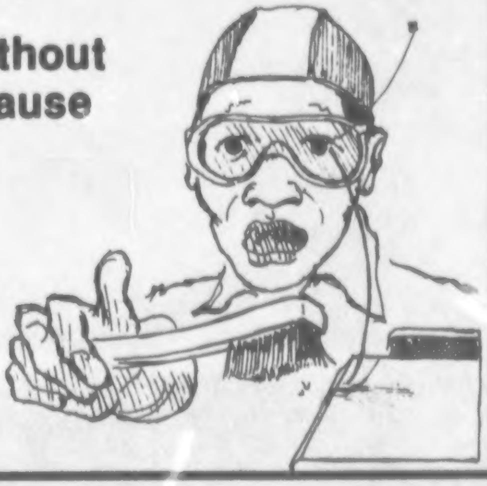


Clean the beveled edges thoroughly.

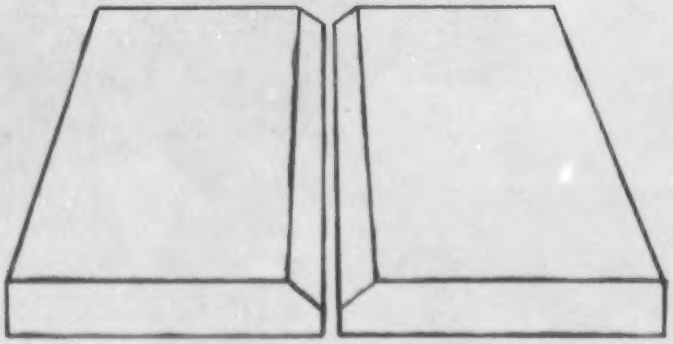


CAUTION!

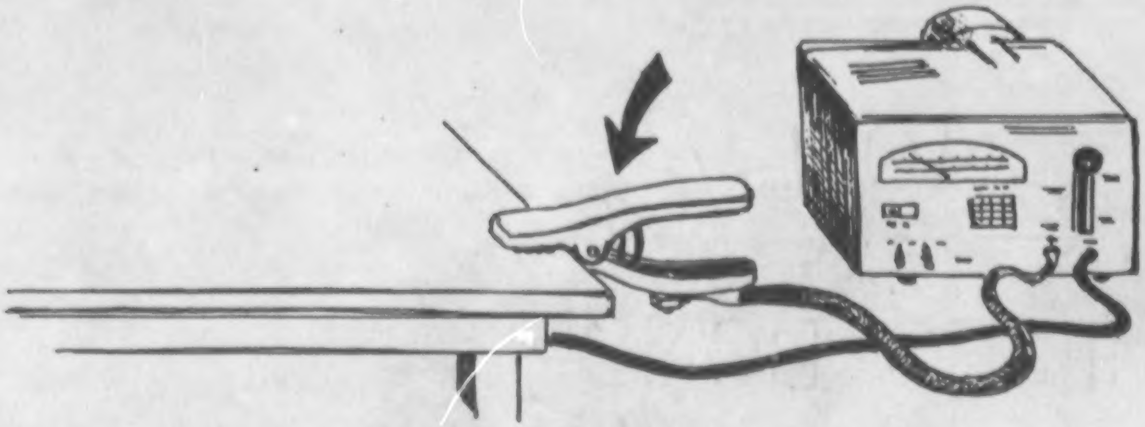
NEVER wire brush metal without wearing safety goggles because the flying metal pieces can injure your eyes.



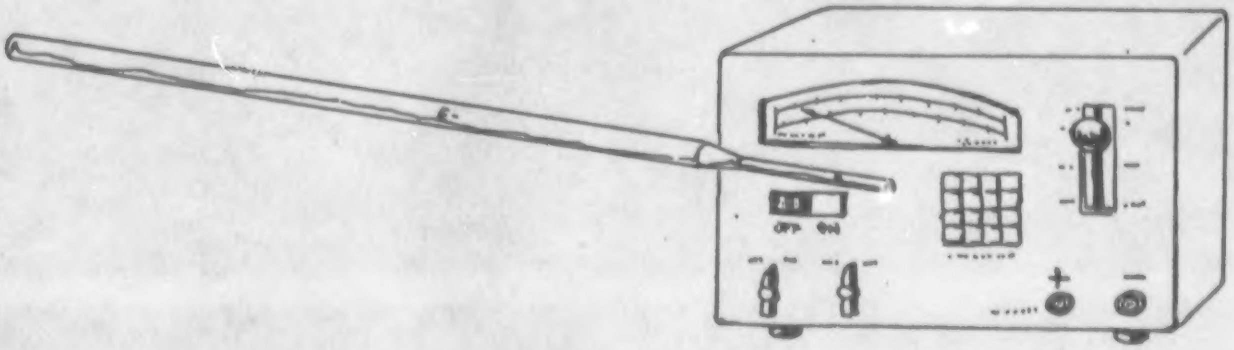
4. Place the two pieces of metal in position for welding.



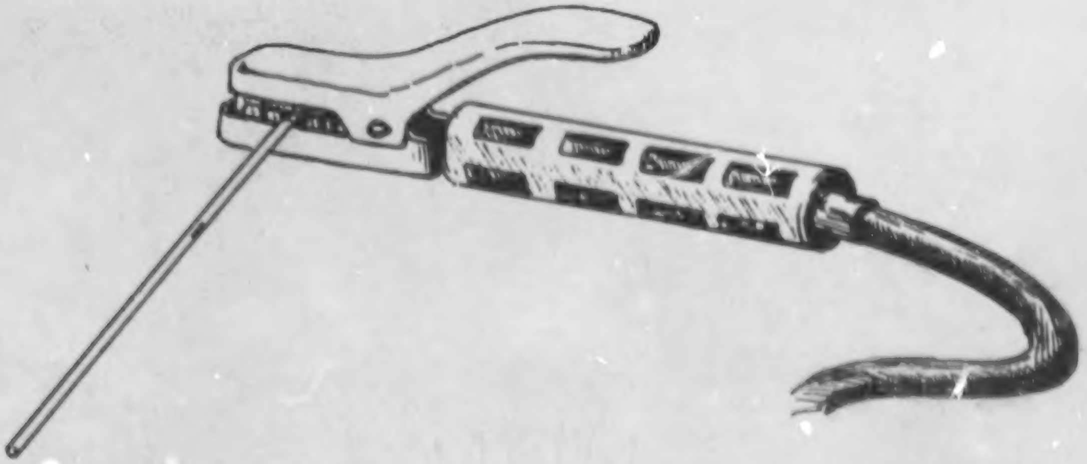
5. Attach the ground clamp to the welding table at a clean spot.



6. Obtain a 5/32" E-6012 electrode. Set the welder to 120 amperes of current. Your instructor may do this for you.

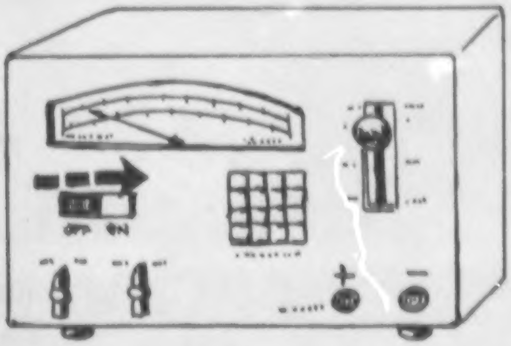


7. Put on your helmet in a raised position. Insert the bare end of the electrode into the holder.

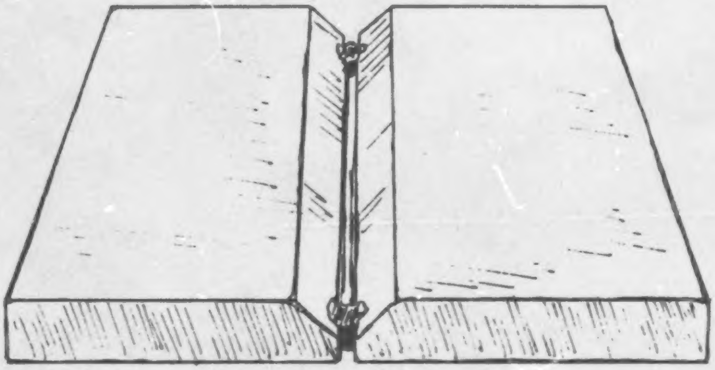


CAUTION!
Keep the electrode holder from touching the base metal or welding table.

8. Switch on the welder.



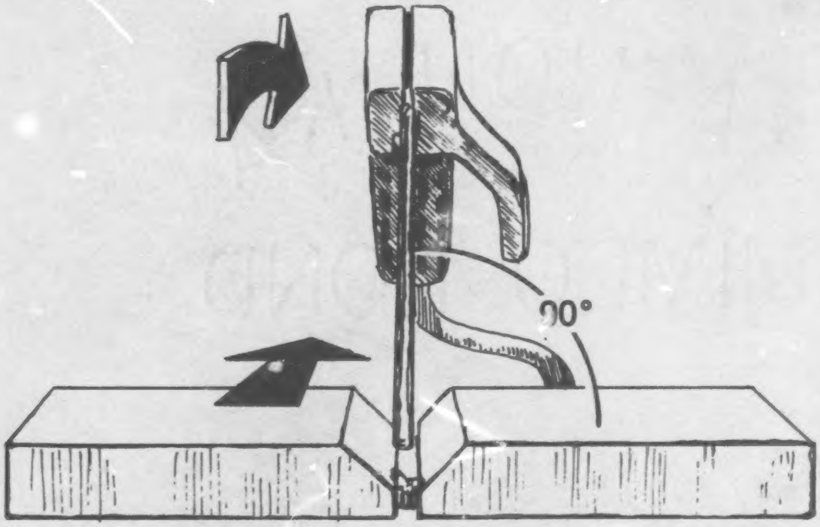
9. Hold the electrode about one inch above each end of the joint. Lower the helmet over your eyes and tack weld the joint.



NOTE!

Tack weld is a weld made to hold parts in a steady position for final welding.

10. Hold the electrode at a 90° angle to the sides and slightly tilted in the direction you will weld.



Start to weld. Direct the arc into the root of the joint.

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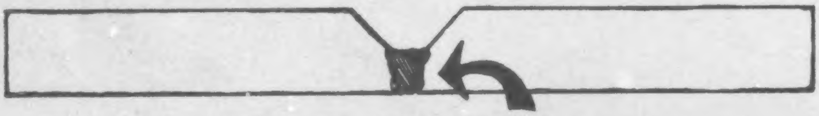
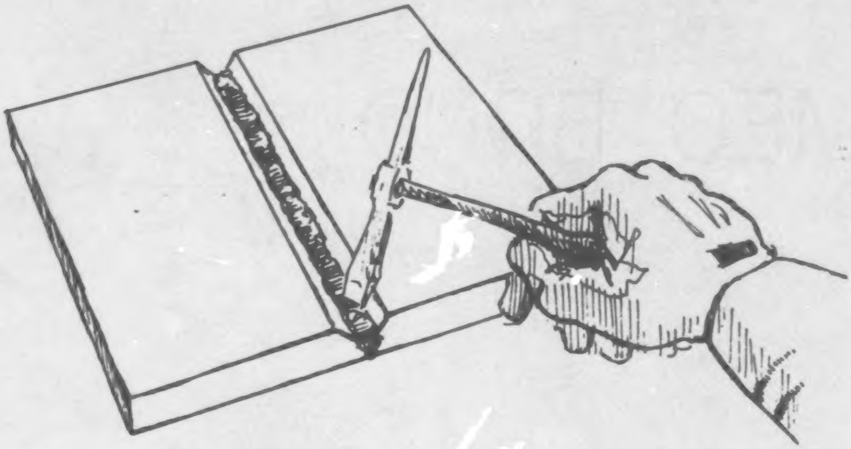
11. Continue welding along the bottom of the V. Make sure that the weld penetrates both sides evenly and goes completely through.

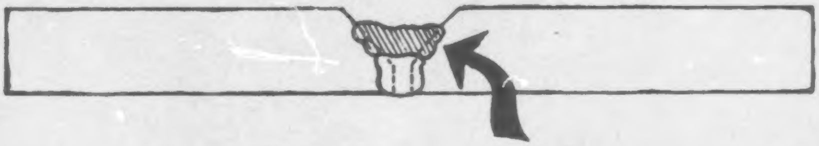


This first layer of beads is called Root Pass.

12. Clean the weld thoroughly with chipping hammer and wire brush.



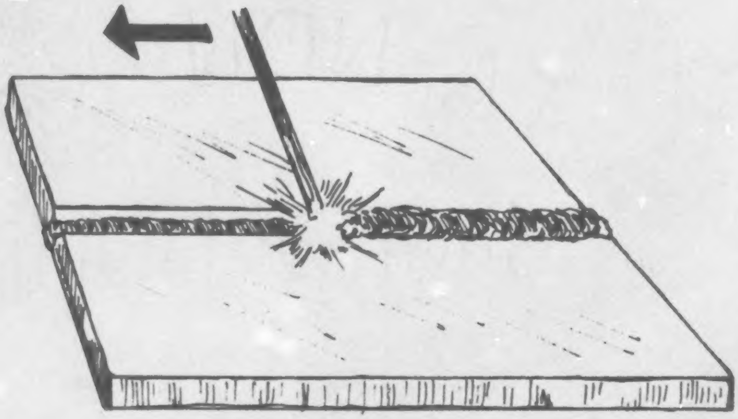
13. Lay a second layer of beads. This layer is called Filler Pass.



14. Thoroughly clean the second layer of beads or filler pass with chipping hammer and wire brush.

180

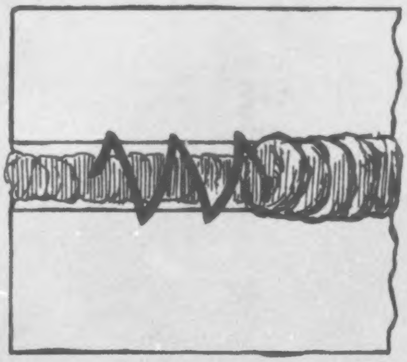
15. Deposit a third layer of beads until it builds up slightly above the surface of the metals. This third layer of beads is called Cover Pass.



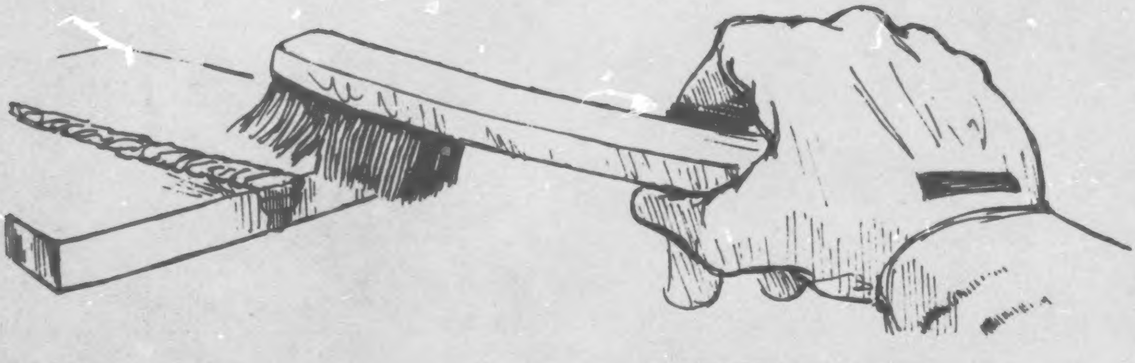
NOTE!

Weave the third or last pass to make sure that the weld penetrates each side of the V-joint evenly.

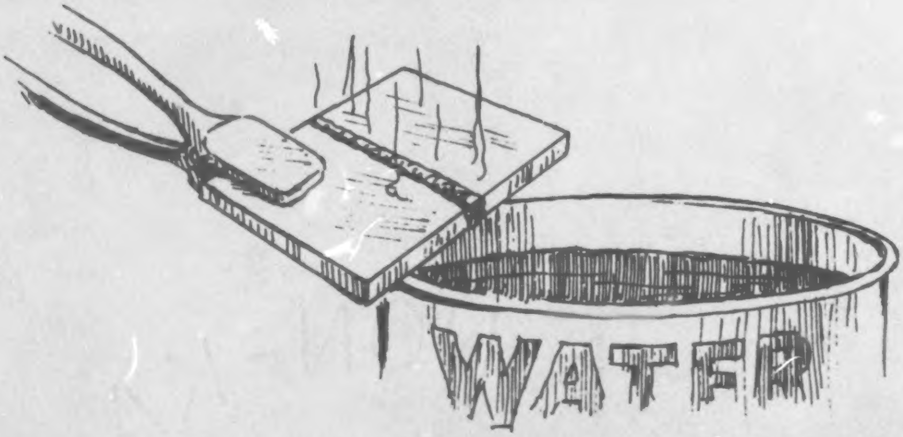
ALWAYS move the electrode fast enough to keep it slightly ahead of the molten pool.



16. Clean the weld with chipping hammer and wire brush. Examine it to find out whether the weld is smooth and evenly made.

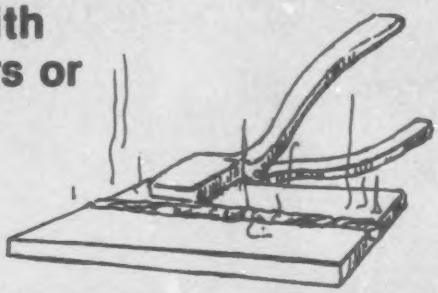


17. Cool the weld in a bucket of water.

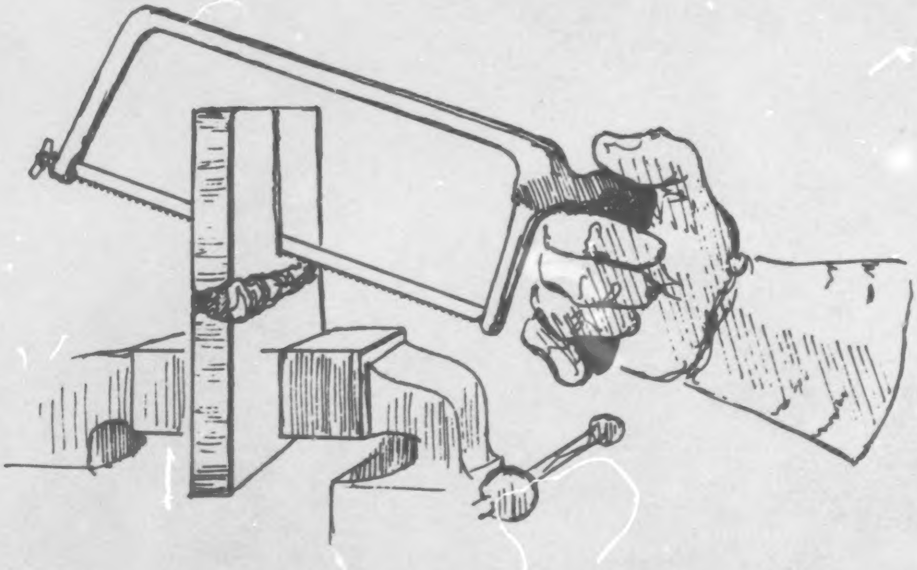


CAUTION!

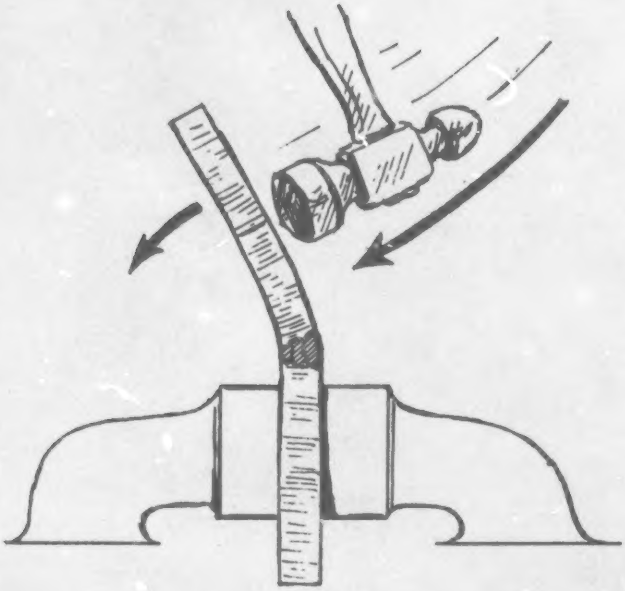
NEVER handle hot metals with your hands. Always use pliers or tongs.



18. Cut the welded joint to obtain a test piece.



19. Secure the test piece in a vise. Hammer it until it breaks or flattens out.



20. Clean up your work area and put the electrode stubs, slags and waste metal pieces into the scrap box.

21. Return tools to their proper places.

SEE YOUR INSTRUCTOR

Unit 13
Welding A Beveled Butt Joint with an Electrode

Practical Exercise Performance Checklist

The student ____________________ successfully performed the following tasks:

Tasks	Yes	No	Comments
1. Wore proper safety equipment			
2. Properly and safely cleaned the base metal joints			
3. Correctly arranged the base metals to be welded			
4. Correctly grounded the welding table for safety			
5. Obtained the proper electrode and correctly set the amperage on the welder			
6. Correctly inserted the electrode into electrode holder			
7. Held the electrode holder safely while switching on the welder			
8. Correctly held the electrode above the beveled butt joint and tack welded each end			
9. Correctly held and moved the electrode while depositing beads along the entire root joint or bottom of the V.			
10. Thoroughly cleaned the first layer of weld beads			
11. Deposited the second layer of beads			
12. Properly and safely cleaned the second layer			

Tasks	Yes	No	Comments
13. Deposited a third layer of beads until it built up slightly above the metal surface			
14. Safely cleaned and examined the weld for smoothness and uniformity			
15. Safely handled and cooled the weld in a bucket of water			
16. Safely cut the weld to obtain a test piece			
17. Tested the strength of the weld with a vise and hammer			
18. Properly cleaned work area and returned tools to their proper places			

Satisfactory Performance ☐
Repeat Exercise ☐
Should Move On ☐

Instructor's Name ________ Date ________

Vocational Preparation Curriculum
WELDING

Unit 14

Welding a Lap Joint with an Electrode

Developed by: Hogan Usoro

PRACTICAL ARTS
AND
VOCATIONAL-TECHNICAL
EDUCATION
IMI
INSTRUCTIONAL MATERIALS LABORATORY
UNIVERSITY OF MISSOURI-COLUMBIA

Unit 14
Welding a Lap Joint with an Electrode

Welding a Lap Joint with an Electrode.

After you have studied this lesson, you should be able to:

1. Clean metal pieces for welding a lap joint.
2. Weld a lap joint with an electrode.

Show What You Can Do.

Check the statement that fits you best.

1. ☐ **I can do all the tasks above and want my instructor to give me the Practical Exercise.**

SEE YOUR INSTRUCTOR

2. ☐ **I want to study the information in this unit before I do the Practical Exercise.**

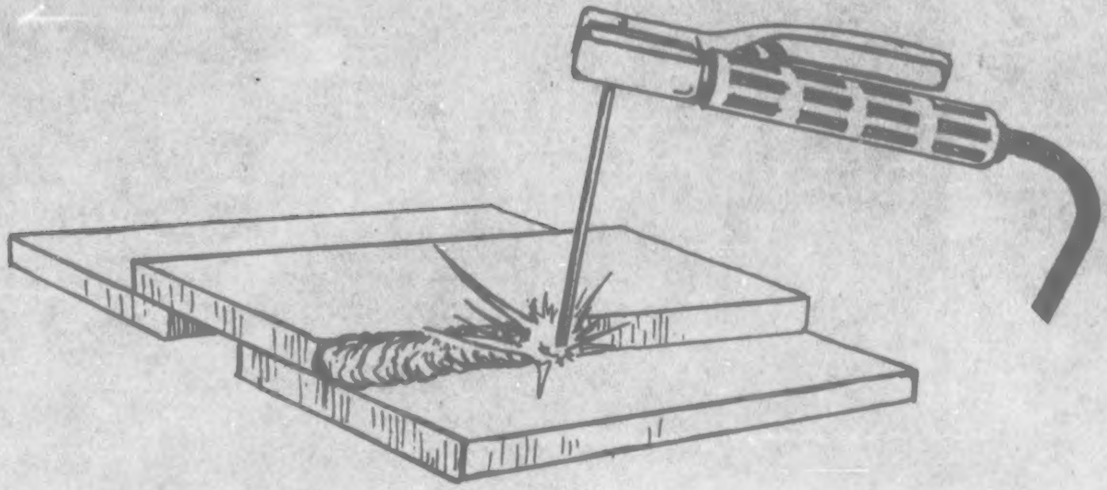
TURN THE PAGE AND BEGIN

Unit 14
Welding a Lap Joint with an Electrode

Introduction

You have learned how to weld a lap joint with a welding torch and filler rod. In this lesson, you will weld a lap joint using an electrode.

Your experience in the past arc welding lessons will help you in this unit.



Now, let us begin.

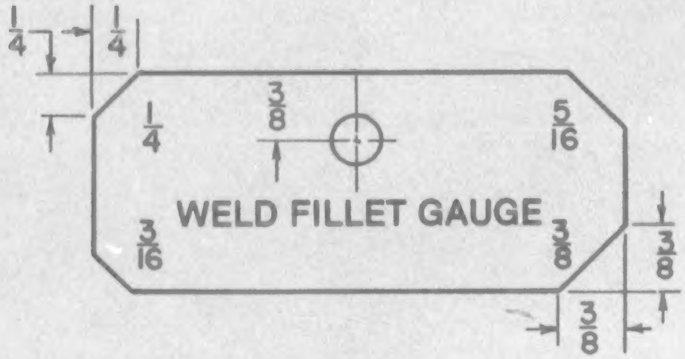
TURN TO NEXT PAGE

Unit 14
Welding a Lap Joint with an Electrode

A. Tools, Materials and Equipment for Welding a Lap Joint with an Electrode.

You have already used most of the tools, materials and equipment needed in this lesson. The only new tool that you require is the Weld Fillet Gauge. It is used to test the fillet weld. A fillet weld is shaped like a triangle.

1. **FILLET GAUGE:** Gauge used to measure the size of a weld.



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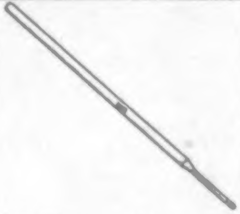
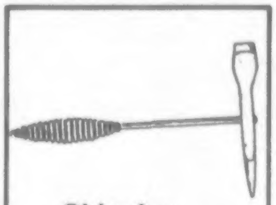
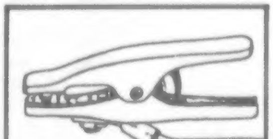
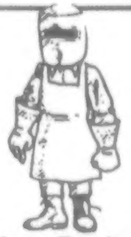
B. Steps for Welding a Lap Joint with an Electrode.

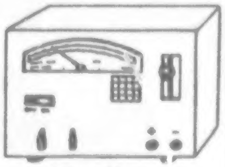
1. Find and Check Off the following:

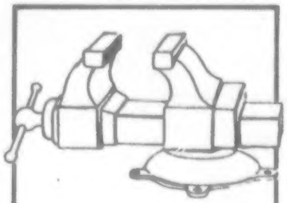

☐ Electrode

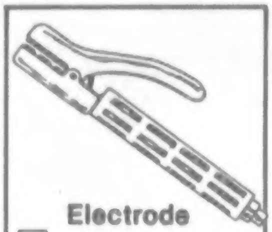

☐ Chipping Hammer

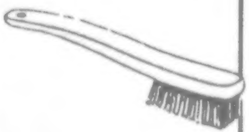

☐ Ground Clamp

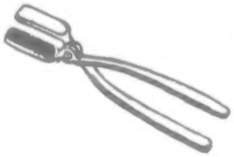

☐ Safety Equip.

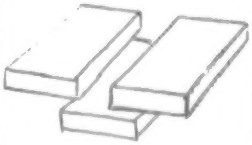

☐ Welding Machine

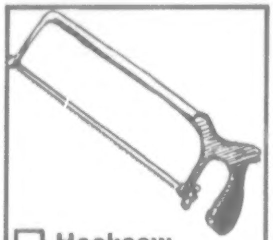

☐ Vice

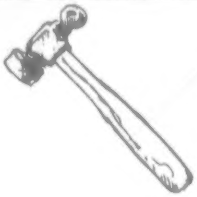

☐ Electrode Holder

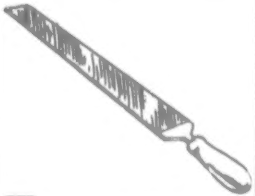

☐ Wire Brush

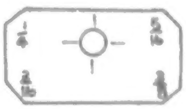

☐ Pliers


☐ Base Metals

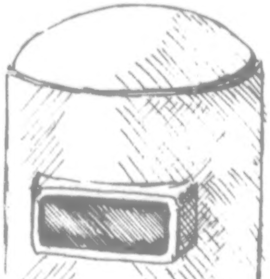

☐ Hacksaw

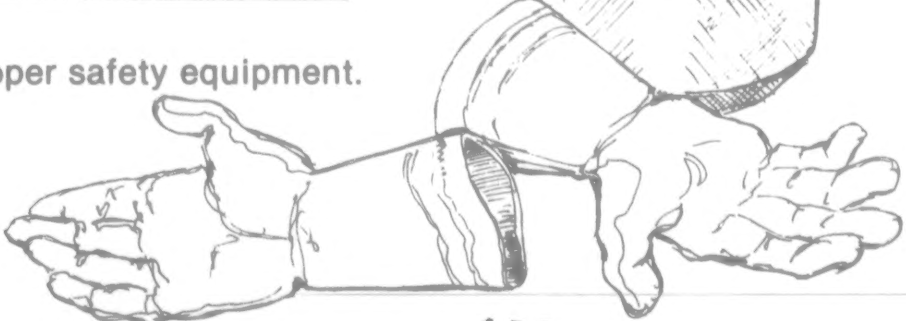

☐ Hammer


☐ Metal File

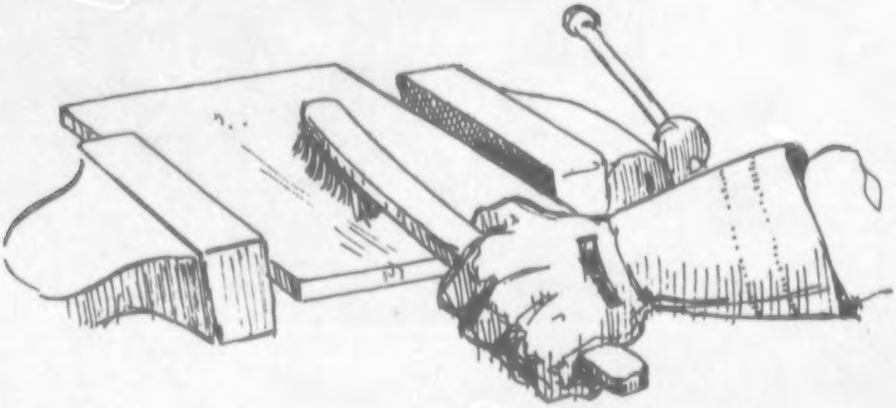

☐ Fillet Gauge

2. Wear proper safety equipment.



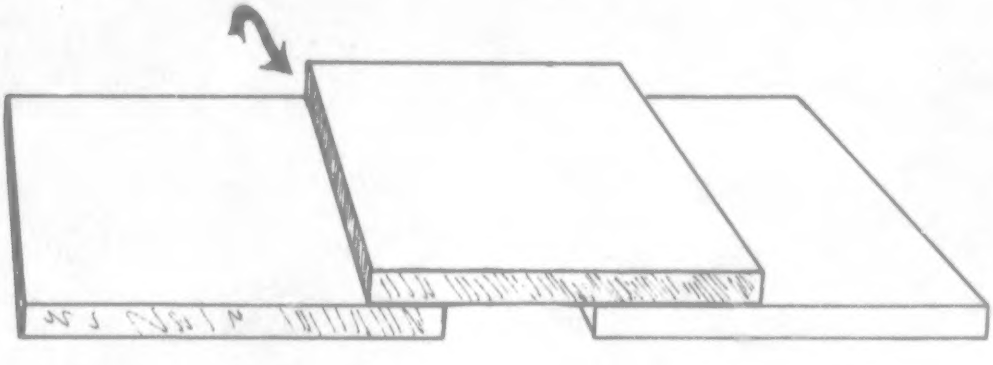


3. Obtain two pieces of base metal, each 1/4"x 6"x 4". Clean each thoroughly.

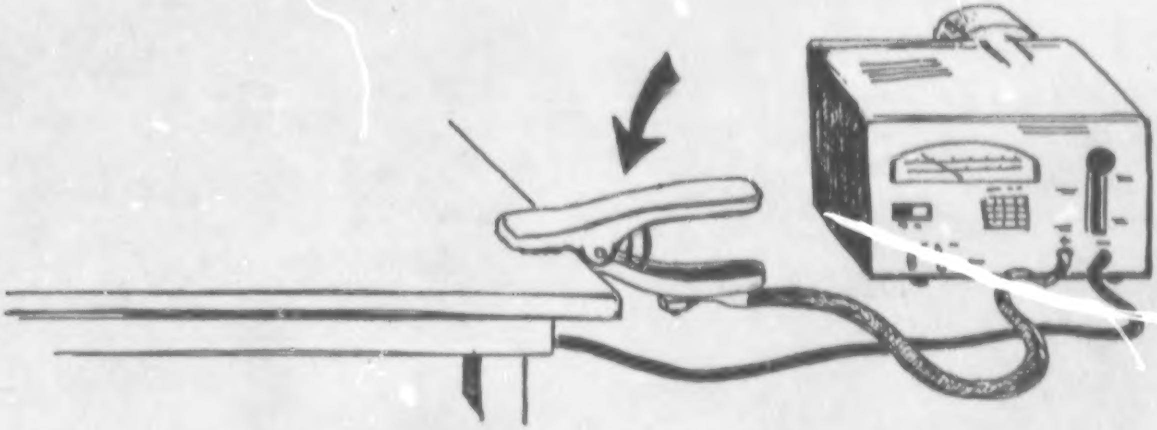


CAUTION!
NEVER wire brush metal without wearing your safety goggles.

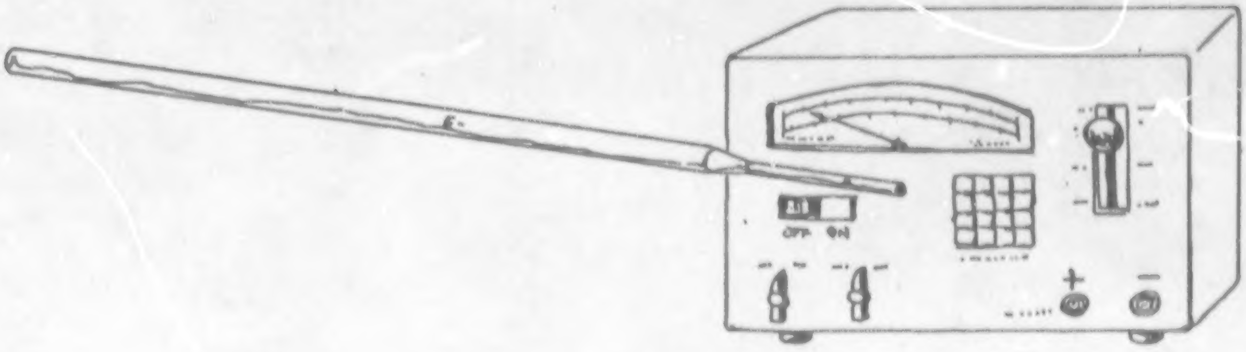
4. Arrange the base metals so one will overlap the other. A third piece of 1/4" thick metal to support the overlapping base metal is needed.



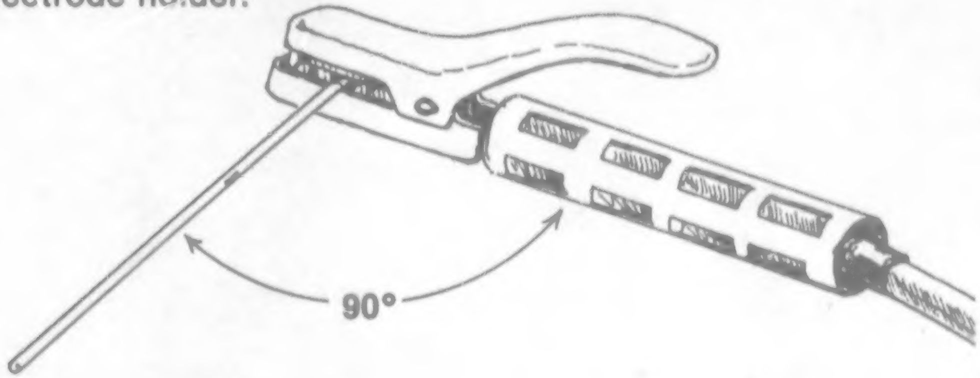
5. Attach the ground clamp on a spot free of rust and paint to insure a good connection.



6. Your instructor will set the welding machine at 105 amperes.



7. Insert the bare end of a 1/8" E-6011 electrode into the jaws of the electrode holder.

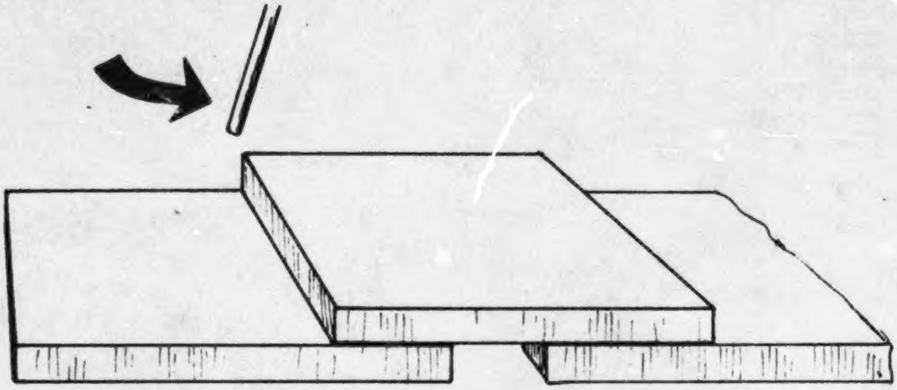


Remember to insert the electrode at a 90° angle to the jaws.

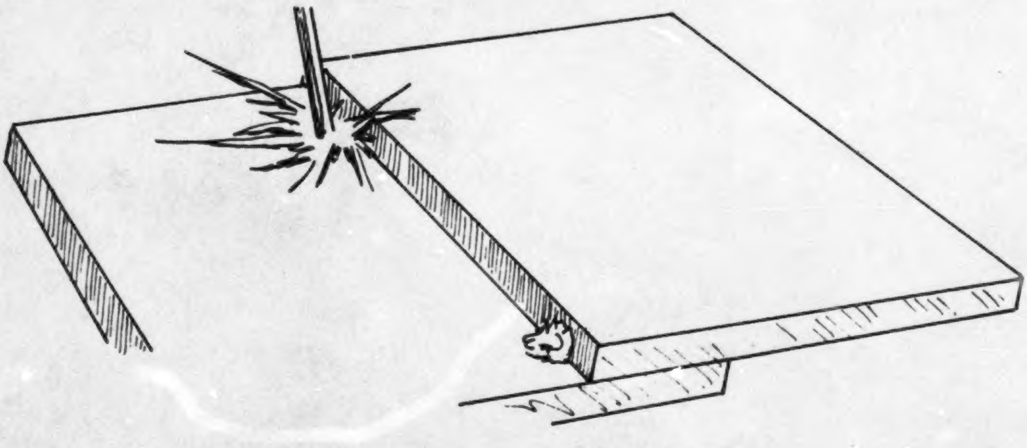
CAUTION!

Keep the electrode and holder from making contact with the base metal or table before you switch on the machine.

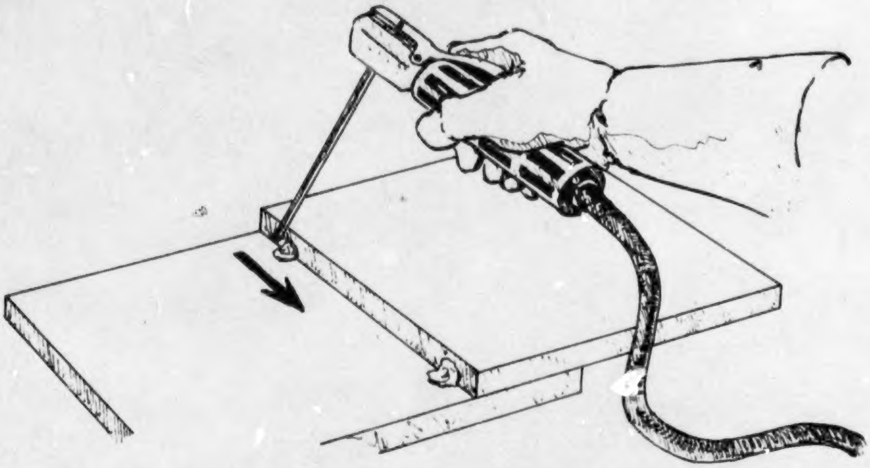
8. Switch on the welding machine and position the electrode about one inch above one end of the lap joint.



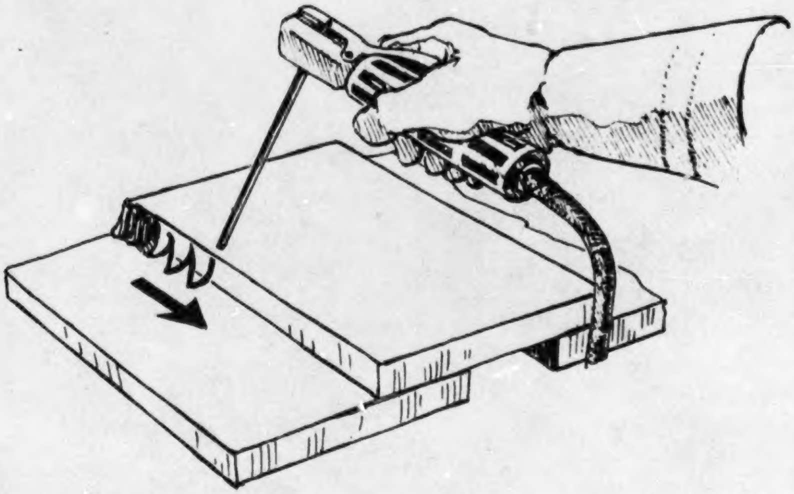
9. Lower the safety helmet to protect your eyes. Tack weld each end of the lap joint.



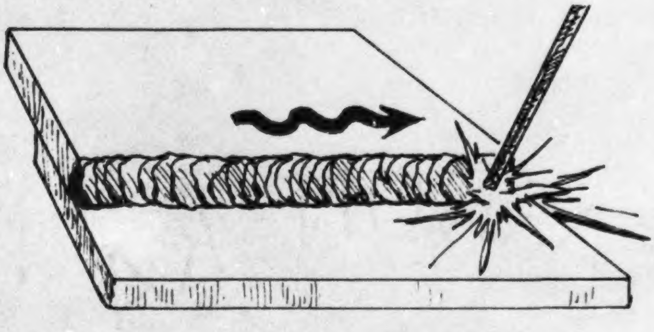
10. Hold the electrode at an angle pointing in the direction of the weld. Begin welding into one corner of the lap joint.



11. Weave the electrode slightly as you run the bead. Maintain the arc for a slightly longer period of time on the lower base metal.

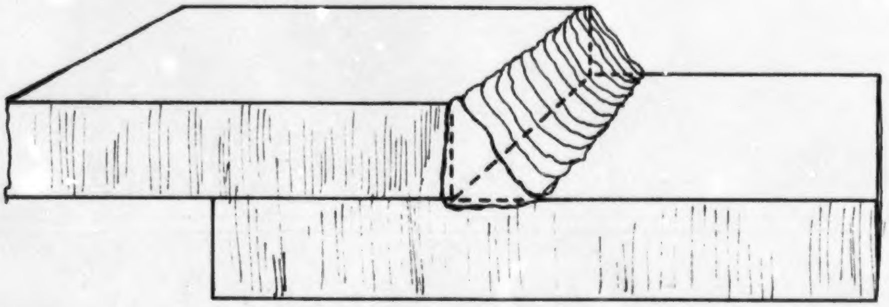


12. Run a 1/4" weld along the entire edge of the lap joint.



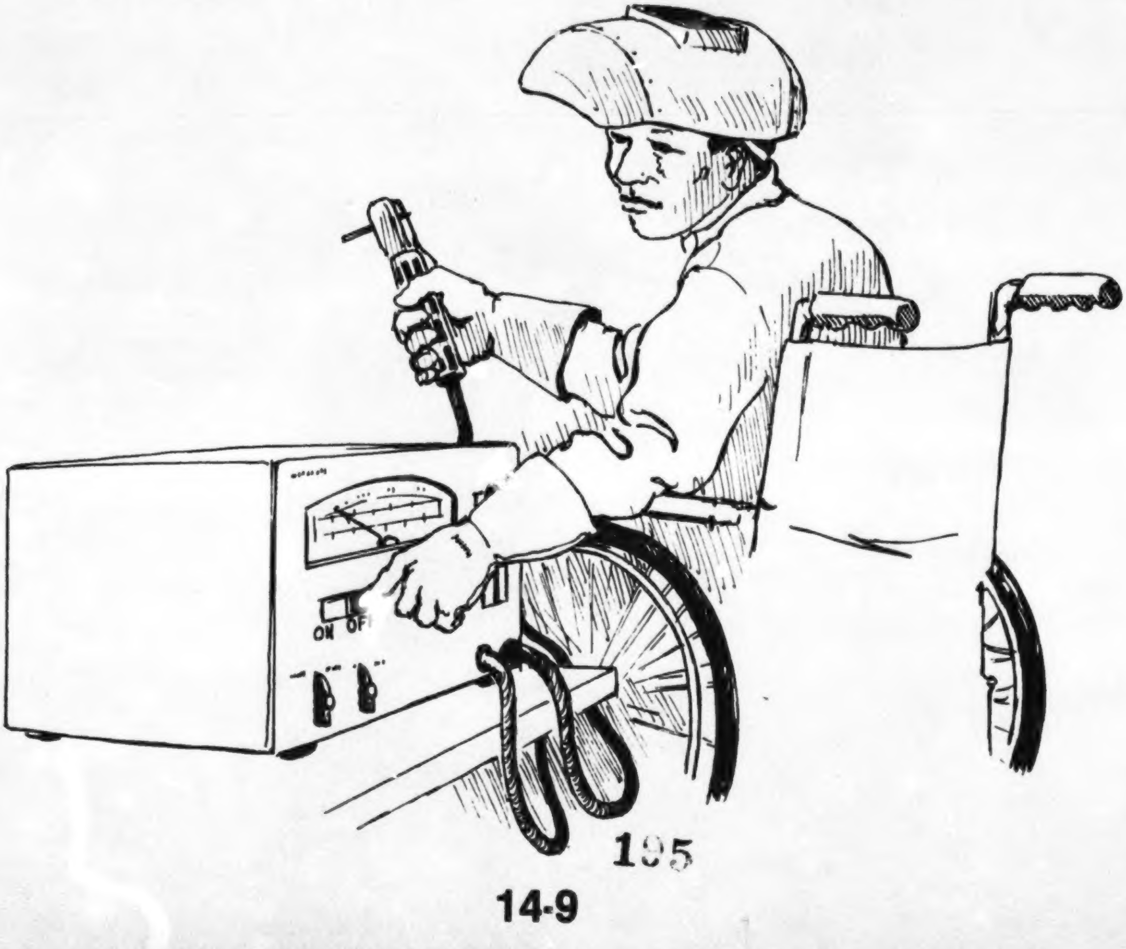
NOTE!

Make sure the weld penetrates both base metals evenly. This is necessary to insure a strong weld.

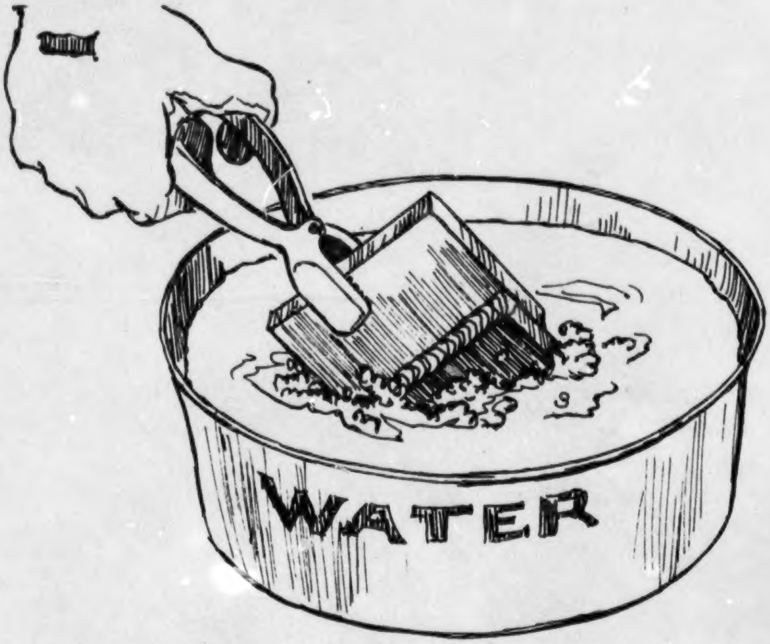


Make sure the weld penetrates both pieces of the joint and builds up to the top of the lapping plate.

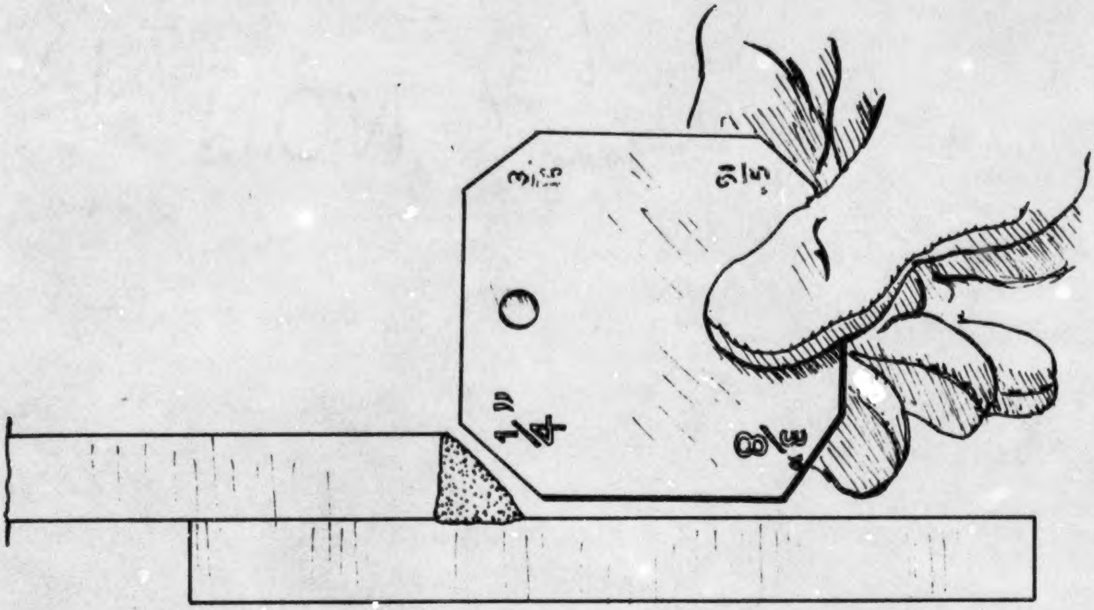
13. After you have welded the entire lap joint, switch off the welding machine.



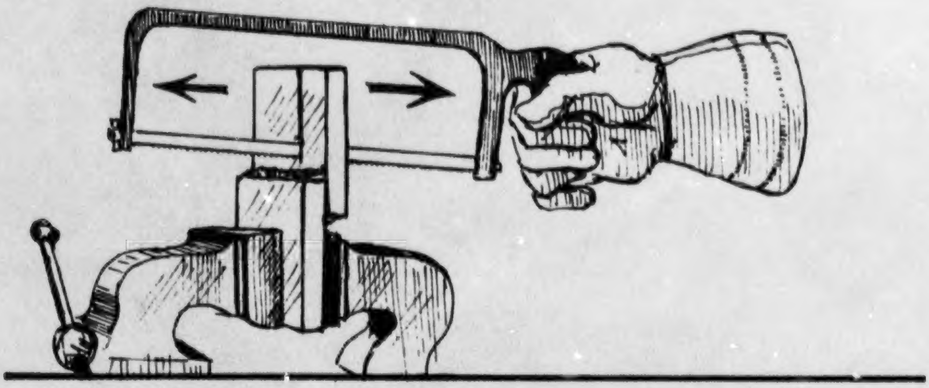
14. Cool the metal in water. Remove slag with the chipping hammer.



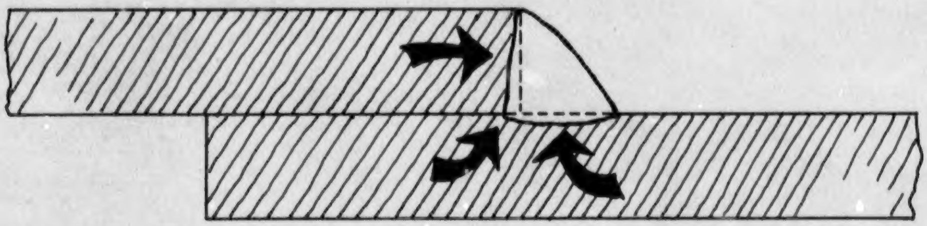
15. Check the size of the fillet weld with the 1/4" side of the fillet gauge.


3/16
5/16
1/4"
3/8

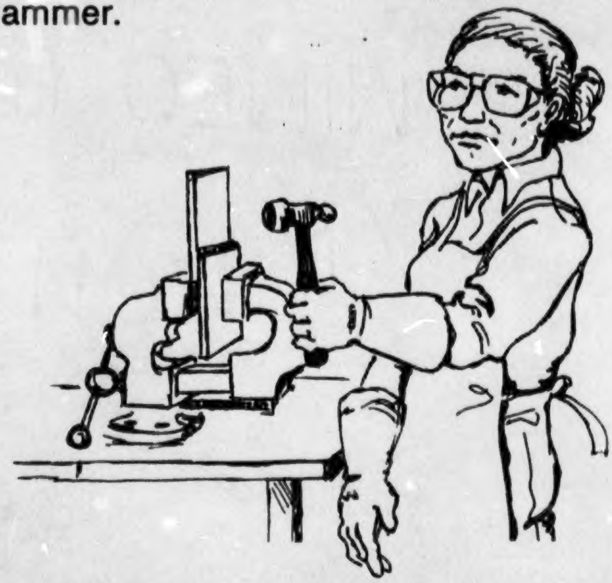
16. Place the welded metal in a vise and cut the weld in half.



17. Examine the sawed edge of the weld. A good weld should penetrate evenly both base metals and the corner.



18. Test the strength of the weld by clamping it in the vise and hitting it with a hammer.



19. Return the tools to their proper places and clean your work area.

SEE YOUR INSTRUCTOR

Unit 14
Welding a Lap Joint with an Electrode

Practical Exercise Performance Checklist

The student ______________________ successfully performed the following tasks:

	Tasks	Yes	No	Comments
1.	Wore proper safety equipment			
2.	Thoroughly cleaned base metals to be welded			
3.	Properly positioned base metals on the welding table			
4.	Properly attached ground clamp to welding table or work piece			
5.	Set the machine to correct amperage and arc voltage (This step can be performed by the instructor.)			
6.	Put on helmet in a raised position			
7.	Secured the bare end of the electrode in electrode holder			
8.	Kept electrode and holder clear of the table or work when switching on the welding machine			
9.	Correctly held the electrode in a ready position to weld			
10.	Lowered helmet to protect eyes before beginning to weld			
11.	Tack welded the lap joint on both ends			
12.	Directed the arc into the corner of the joint and ran 1/4" fillet weld along joint			
13.	Wove the electrode as the fillet was run			
14.	Built the weld from root of joint to the top of lapping plate			

Tasks	Yes	No	Comments
15. Switched off the machine after welding			
16. Cooled welded metal in a bucket of water			
17. Removed slag from the weld with a chipping hammer			
18. Checked the size of the fillet with a weld fillet gauge			
19. Cut the weld into two halves and examined the weld penetration			
20. Tested the quality of the weld with a vise and hammer			
21. Returned tools to their proper places			
22. Cleaned up the work area			

Satisfactory Performance ☐
Repeat Exercise ☐
Should Move On ☐

Instructor's Signature ____________ Date ______